JUNE 1957

# Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

*From the Past . . .*

**INSPIRATION**

*For the Present . . .*

**ACCOMPLISHMENT**

*To the Future . . .*

**DEDICATION**

*Plows 6 to 8 extra acres every day...*

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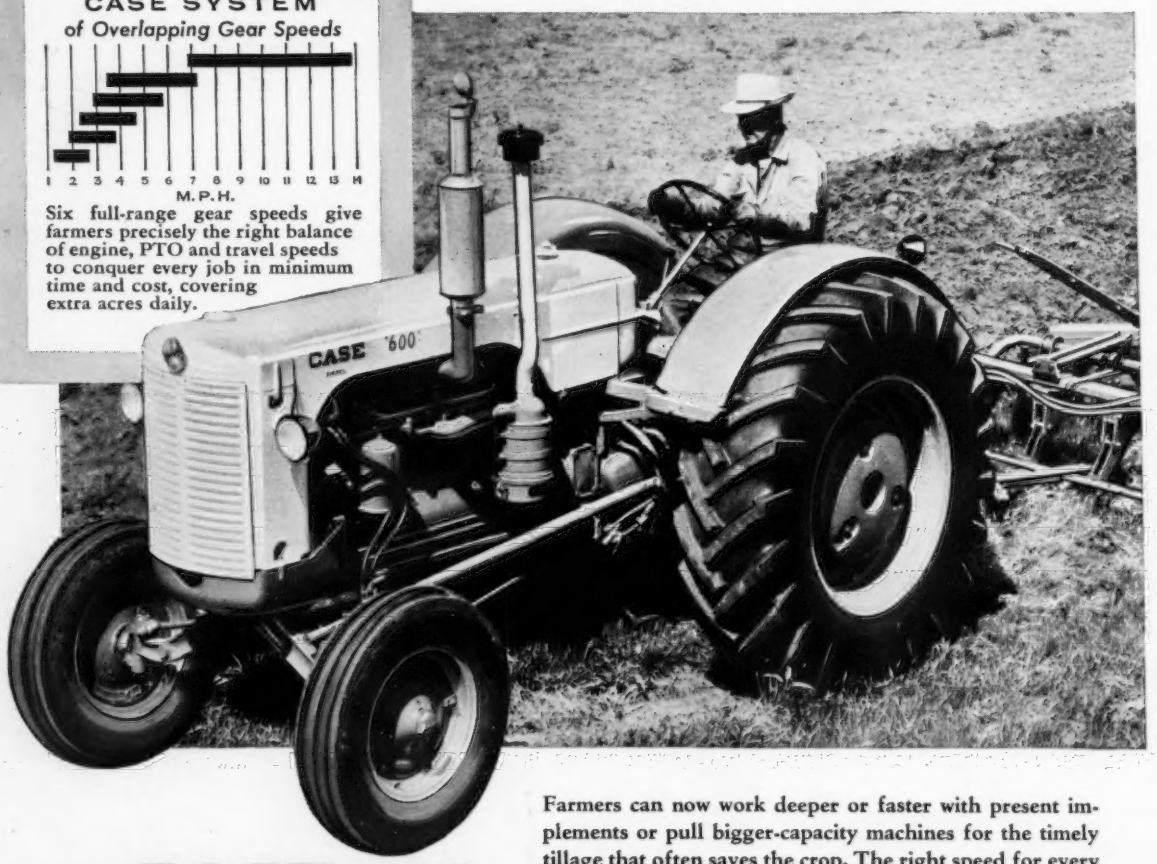
*of Overlapping Gear Speeds*




Six full-range gear speeds give farmers precisely the right balance of engine, PTO and travel speeds to conquer every job in minimum time and cost, covering extra acres daily.




## New CASE® 600

*King of 6-Plow Tractors*

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Farmers can now work deeper or faster with present implements or pull bigger-capacity machines for the timely tillage that often saves the crop. The right speed for every load and job spares time and fuel. High torque provides great lugging reserve when overloads are encountered, reducing need for gear shifting. New, faster power steering does the hard work in rough going. Six-cylinder smoothness delivers top power and economy on diesel or LP-gas.

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Name_____

Position_____

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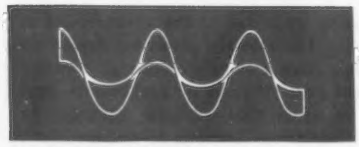
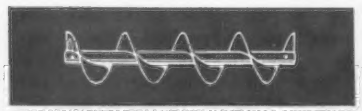
Flexible in application . . . versatile in operation

# Link-Belt augers simplify design

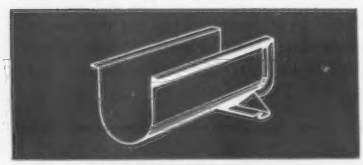


**SELECTED FLIGHTING** for all your auger needs. Helicoid, sectional or a range of other types of flighting are available in the metal and finish best suited for your design.



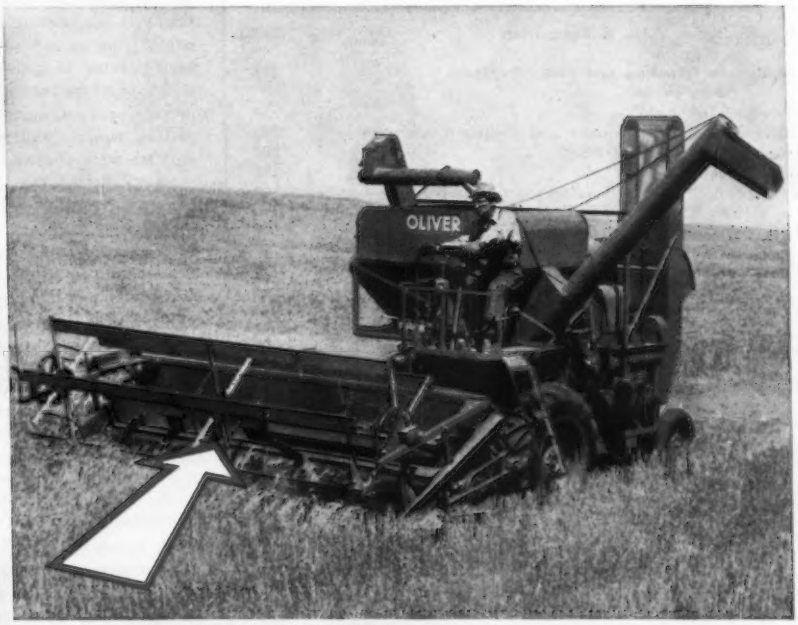
**SIMPLICITY OF CONSTRUCTION** and sturdy design of Link-Belt augers provide dependable, efficient operation on your machine. One basic assembly with no other moving parts to break down.

**YOUR CHOICE OF METALS** answers your requirements for handling corrosive or abrasive materials. And Link-Belt uses only specially selected steels to assure a uniform product.



**ALL COMPONENTS** — conveyor screws, collars, couplings, hangers, troughs, trough ends, flanges, drives —are available for every design.

**ENGINEERING SERVICES.** Our auger specialists will help you analyze your special needs . . . integrate all elements of your design.



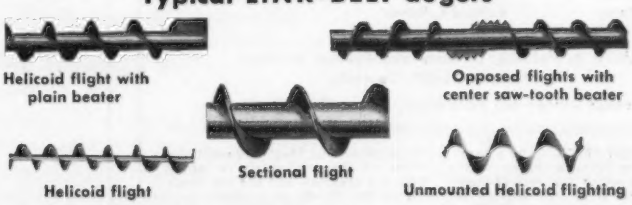

**SELF-PROPELLED OLIVER COMBINE** uses Link-Belt auger for smooth, efficient grain harvesting. Auger incorporates opposing flights with center saw-tooth beater for even delivery from both sides—provides maximum strength for longer life. Other Link-Belt screw conveyors are used for elevating, conveying and unloading harvest within combine.

You can be sure of efficient operation, long life and low maintenance when you make a Link-Belt auger part of your equipment.

Link-Belt has a wide selection of augers, many of a specialized design, in a full range of diameters, gauges and pitches. They're accurately made to assure easy assembly, smooth, dependable operation. In addition, all components can be adapted to your particular design.

Whether it's a new application for your present machines or an entirely new concept, simplify your design problems by specifying Link-Belt augers. Call your nearest Link-Belt office for complete information.

## Typical LINK-BELT augers

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**FARM MACHINE AUGERS**

14,600

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# Agricultural Engineering

*Established 1920*

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## Foreword . . .

THIS issue of the Journal is designated as a special number to help commemorate the 50th anniversary of the founding of the American Society of Agricultural Engineers as a professional engineering society dedicated to the advancement of engineering in agriculture. The material presented herein has been selected to make this issue a complete (though concise) and factual record of the past 50 years of agricultural engineering advancement. In order that editorial coverage be divided equally among the various interests of our members, authors were chosen from each ASAE professional division.

A great amount of personal effort and sacrifice has gone into the production of this special number on the part of the contributing authors. ASAE is indebted to those members who have taken personal satisfaction in making these contributions to the literature of the Society.

The great progress which has taken place in our profession during the past 50 years, and which is described in the various articles in this issue, inspired the trilogy on the cover. *From the Past . . . Inspiration* is the stimulus beyond duty incited and transmitted by the founders of ASAE and those who have led in agricultural engineering developments of the past 50 years. *For the Present . . . Accomplishment* is today's product of inspiration and abilities marking new plateaus of professional and technical achievement. *To the Future . . . Dedication* means sustained devotion and diligence in the fulfillment of professional objectives.

A recent book on agricultural engineering lists the broad basic objectives of our profession as: To reduce the hazards of farming; to reduce production costs; to improve and retain the quality of farm products; to utilize profitable farm by-products and surplus; to remove drudgery from farming operations; to make farm life more enjoyable; and to conserve and use more efficiently our national resources. As agricultural engineers we can be proud that dedication to our objectives will also help to provide food, fiber and other materials for well-fed, well-clothed and well-housed future generations.

The increased size of this issue has been made possible by companies and organizations that have purchased advertising space.

Since it has been impossible to publish all the articles that have been prepared or could have been written for this special issue, other Golden Anniversary feature articles will appear in the remaining issues of AGRICULTURAL ENGINEERING during 1957.

• • •

American Society of Agricultural Engineers
Organized 1907
This is to certify that
Dwight D. Eisenhower
is an Honorary Member of the
American Society of Agricultural Engineers,
an organization formed to promote the Art and Science of Engineering as applied to Agriculture, and that his membership in the Society dates from 1957

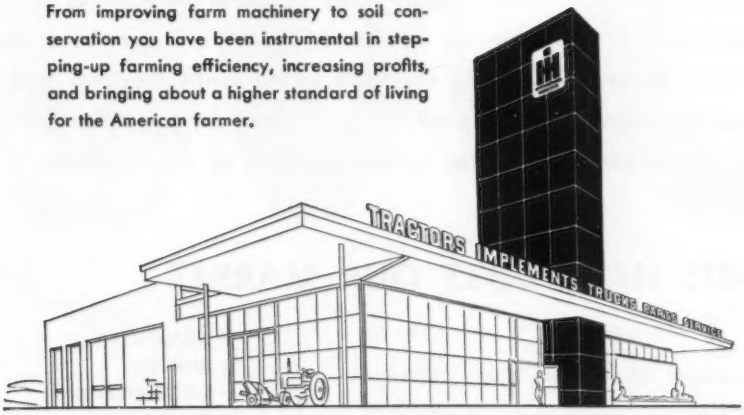
Honorary Membership Certificate presented to President Eisenhower.
See story on page 462

# International Harvester Salutes the

# A.S.A.E.

## on its 50th Anniversary

For 50 years you as agricultural engineers have played an important role in improving farming standards. You are to be congratulated on bringing to the American farm the many advantages of modern engineering. From improving farm machinery to soil conservation you have been instrumental in stepping-up farming efficiency, increasing profits, and bringing about a higher standard of living for the American farmer.




**Wherever Americans farm . . .**

Farmall® . . . International® . . . McCormick® . . . household words on America's family farms . . . represent the finest in modern, labor-saving tractors and farm equipment. Built by International Harvester with unmatched research, engineering, and manufacturing knowledge . . . IH machines are proved and tested, precision-built for highest efficiency on every job.

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# GOLDEN ANNIVERSARY

# CONGRATULATIONS

## TO AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

*for your great contributions to raising the American living standards*

**In just over 15 years the productivity of the American farm workers has doubled with far-reaching effects upon the nation. More food for all to provide the finest menus to Americans that the world affords. Higher incomes are paid to farm producers and urban people alike; a great abundance of products of all species are available to everyone; industries have been spawned, nurtured and matured to supply the tools to the farm producer and process his expanding output. *This has all resulted from the increased farmer productivity. This is the result of the creative efforts of the members of ASAE.***

## YOUR EFFORTS HAVE BUILT OUR MARKET

The replacement of human labor with machines has been an engineering, production, distribution achievement made possible by ASAE members. The need for power transmission in this development has provided a big market for our rubber products. We list a few farm products that we are proud to have carry Durkee-Atwood V-Belts.

- COMBINES
- MOWERS
- CORN PICKERS
- TRACTORS
- HAY BALERS
- RAKES
- ELEVATORS
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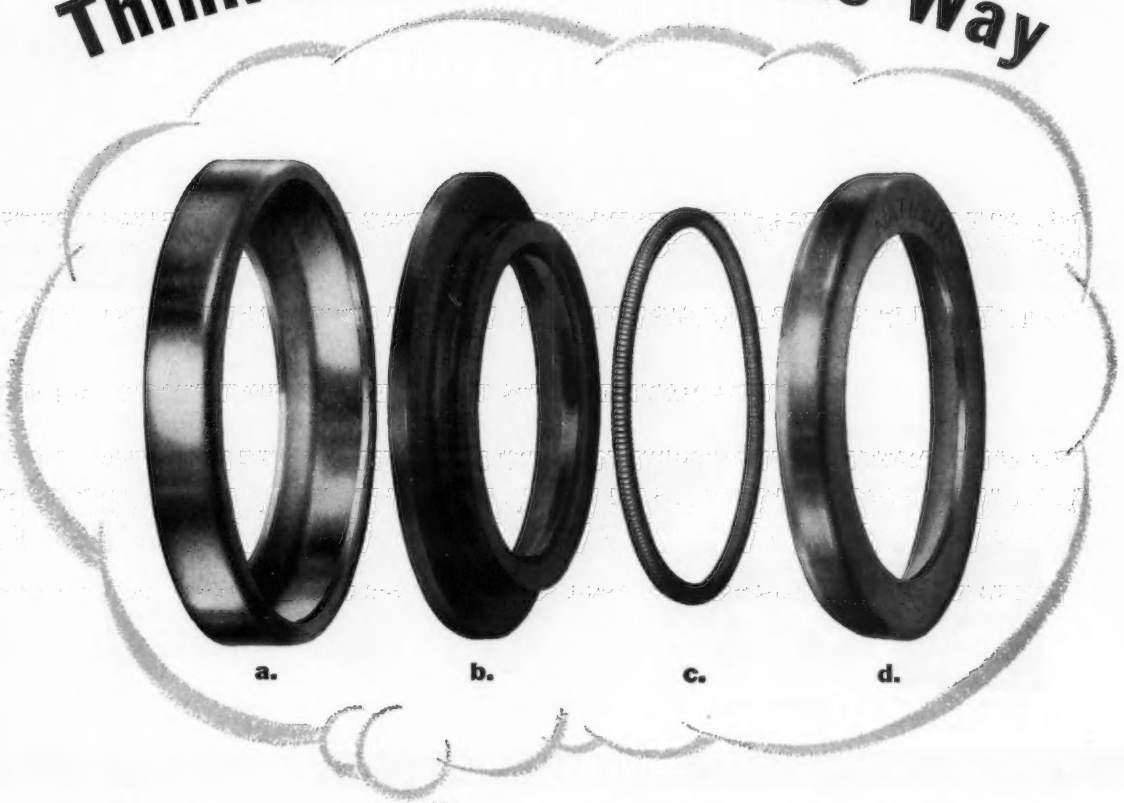
## When you design-in seals

# Think of Oil Seals This Way




### a. Outer Case

Formed to extreme close tolerance of heavy gauge steel with sufficient structural strength to maintain precision dimension.

### b. Sealing Lip

Properly prescribed material either compounded or processed for application conditions of temperature and eccentricities. Precisely molded for correct shaft interference, low torque and positive sealing.

### c. Tension Spring

Carefully engineered as to metallurgy, heat treatment and coil diameter to provide uniform compressive force on the sealing element.

### d. Inner Case

Strengthens, protects; sturdy gauge steel formed to close tolerances.

4227

A good oil seal is a carefully engineered, precision manufactured assembly of carefully engineered, precision manufactured components. Each part must be exactly right *for the given application* or the seal will not function properly.

You avoid dangers of costly retooling, remanufacture or premature replacement when seals are correctly specified during your product's design stage. Each sealing application is different; many designers use National's field engineering service to be sure correct—and latest—oil seals are used.

Why "do it yourself?" Call the National Seal field engineer now. His service involves no obligation.

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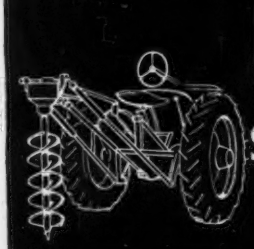
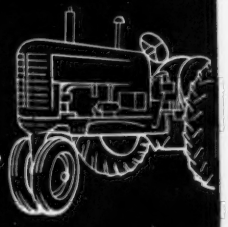
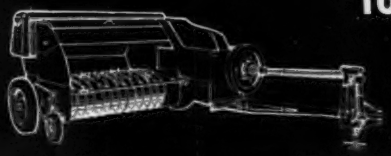
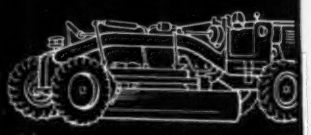
# NEAPCO P.T.O. JOINTS



## SINGLE JOINTS in a variety of sizes. Complete DRIVE ASSEMBLIES to your specification.







Neapco is your best source for a complete range of P.T.O. Joints. They are rugged, precision built for light, medium, and heavy duty applications. Supplied with plain or needle bearing Journal Assemblies in a wide variety of yoke combinations (see below).

Neapco 1800 Series Heavy Duty P.T.O.

Standard Equipment for many leading manufacturers of Dump Bodies, Hoists, Elevators, Loaders, Lime Spreaders, Steering Controls, Auxiliary Drives, Balers, Mowers and others.

**SINGLE JOINTS**

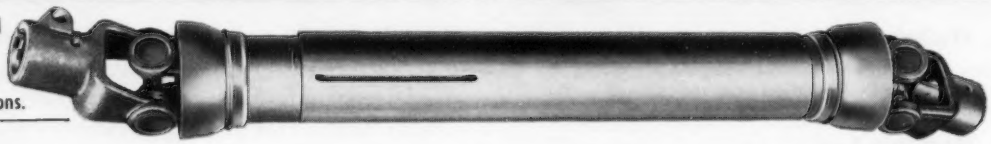
Standard Length

Short Length

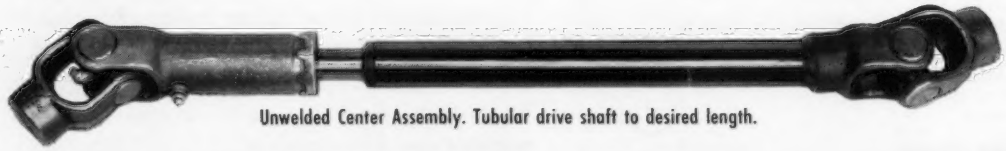
Slip Length

## DRIVE ASSEMBLIES

Safety shielded assembly for exposed drive shaft applications.



Telescoping drive shaft. Square or rectangular.



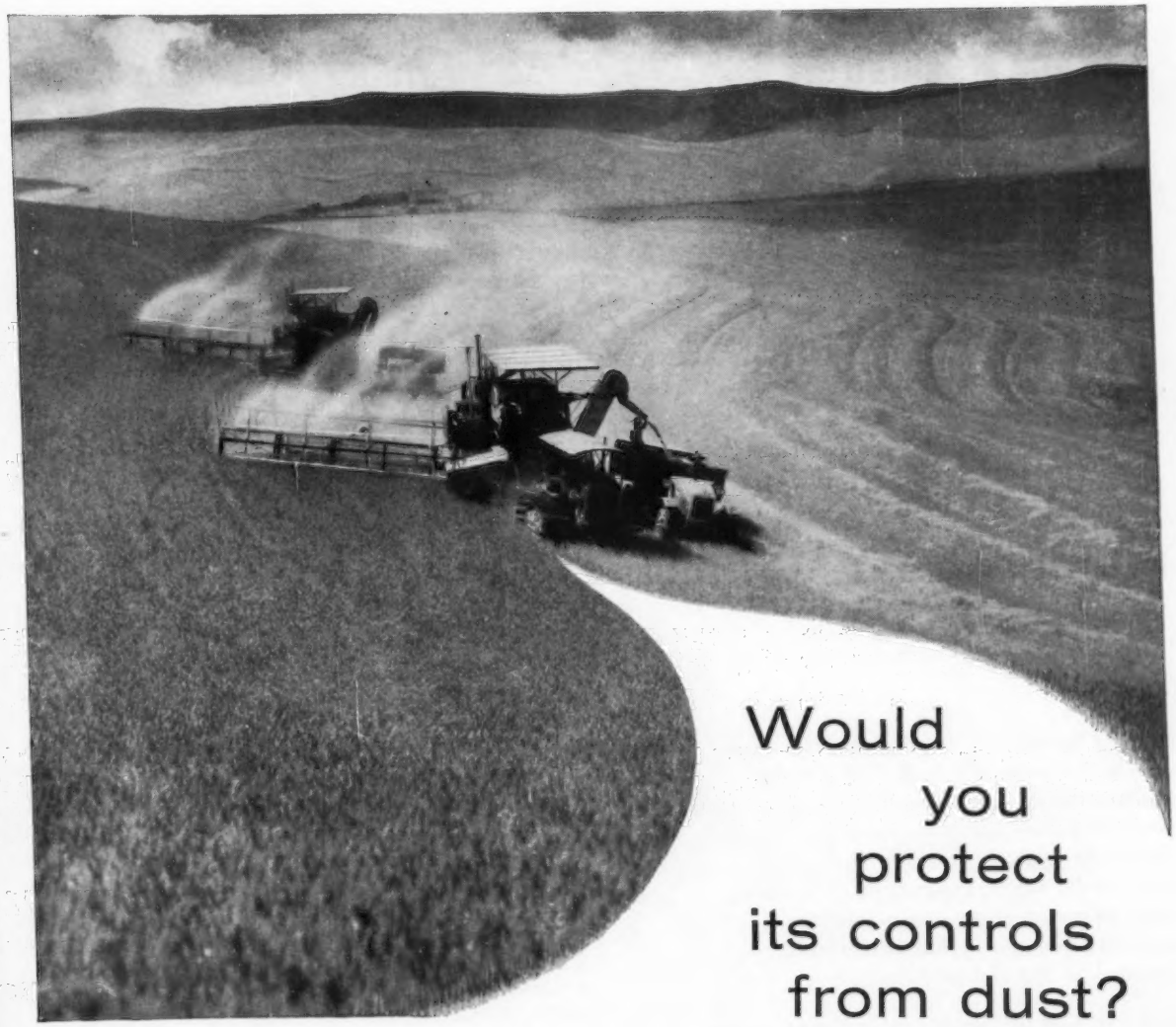
Unwelded Center Assembly. Tubular drive shaft to desired length.

## END YOKES—COMPLETE RANGE OF BORE SIZES.

Standard Round | Short Round | Square | Slip Length | Quick Disconnect | Clamp Type

Write for free engineering literature, or send us your specifications. Neapco will also design assemblies to meet your requirements.

NEAPCO PRODUCTS, INC. POTTSTOWN, PA. USA.



# Would you protect its controls from dust?

Call it dirt, call it dust, call it chaff . . . call it whatever you like—agricultural machinery is never free of it. That, plus the fact that when agricultural machinery is needed, it's needed now, makes protection against contamination a crucial consideration in designing agricultural equipment.

Breakdowns spell disaster in this seasonal business. That's why you would never let a tractor out of the plant without an oil filter. And that's why today's increasingly complex machines need the same protection for their sensitive controls. A hydraulic life on a grain combine, for example, can be stopped cold by a speck of grain, a piece of dirt, or one of scores of particles that cloud the air during normal farming operation. But every particle as small as .000039 inch will be removed if you design Purolator filters into your control systems.

The controlled porosity of Purolator's Micronic element accounts for this unbeatable efficiency. The Micronic element is not affected by high temperatures, water, or oil. It is available in standard filters from Purolator's stock of over 2000 models.

Get complete information from Purolator's 32-page "Filtration Manual for Product Designers". Enclose 25¢ to cover postage and handling. Address Dept. AG-631.

*Filtration For Every Known Fluid*

**PUROLATOR**

**PRODUCTS, INC.**

Rahway, New Jersey and Toronto, Ontario, Canada



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ONE OF A SERIES . . .

# What makes Hyatts run smoother and longer?

# CARBURIZED INNER RACES

From a fatigue life standpoint, the inner race is the critical member of a roller bearing, because the smaller area of contact between rollers and inner race concentrates the loads upon it. That's why HYATT goes to the added expense of *carburizing* every inner race—to assure you the performance and fitting advantages detailed at the right.

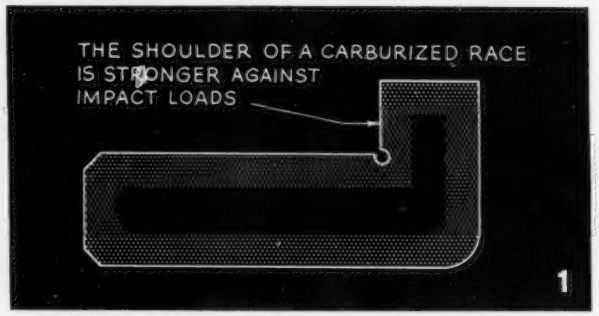
You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey. Sales offices at Harrison, Pittsburgh, Detroit, Chicago and Oakland, Cal.

## HEAVIER INTERFERENCE FITS

Resistance to relative movement between inner race and shaft is vital to good performance. So HYATT makes practically all inner races of carburizing type nickel alloys instead of through-hardened steel. After carburizing and heat-treating, the outer surface has the hard wear resistance so necessary for an efficient bearing. The low-carbon core remains tough and ductile to permit much heavier interference fits than are otherwise possible.

## TOUGHER FLANGES, GREATER LOAD CAPACITY

Carburizing also enables HYATT to obtain substantially tougher inner race flanges. Tests show the shoulders will withstand considerably greater impact loads (Figure 1). The carburizing process has also been found to increase the load-carrying capacity of the race by building up compressive hoop stresses in its external fibres during quenching.




## SIMPLER, LOWER-COST MOUNTING

Another advantage of HYATT'S heavier interference fits is the elimination of all auxiliary holding devices. When the carburized inner race is either pressed or shrunk on the shaft according to HYATT fitting recommendations, it becomes practically an integral part of the shaft itself. This permits mountings of the simplest type and lowest overall cost.

GM GENERAL MOTORS

# HYATT HY-ROLL BEARINGS

FOR MODERN INDUSTRY



For more facts circle No. 17 on reply card

# Report to Readers . . .

**ENGINEERING EVOLUTION IN FARMING - FIRST FIFTY-YEAR MILESTONE** The dignity of man, a status bestowed on him by his Maker, is never served by his becoming a drudge, either willingly or by force of circumstance. The Book of Genesis puts it this way: "And God said . . . let them have dominion . . . " In past centuries, eking out a living from the soil has all too often involved more of subjection than of dominion . . . But in the early years of this century a new voice began to proclaim a happier dispensation for the man on the land, promising wide substitution of mechanical for muscular energy in farming. This was the voice of agricultural engineering uttered by a small group of doughty, far-seeing engineers. This group called themselves "agricultural engineers;" they founded a professional engineering society and called it the "American Society of Agricultural Engineers" . . . They are this year celebrating the Golden Anniversary of ASAE, and this issue of AGRICULTURAL ENGINEERING was planned especially to aid readers in visualizing, in some measure, the progress represented by the first fifty-year record of agricultural engineering development. It is indeed a record in which members of the agricultural engineering profession may well take justifiable pride.

**ENGINEERS HOLD THE KEY TO CONTINUED PROGRESS.** The following summary from a recent economic newsletter issued by the Farm Equipment Institute, and authored by two Purdue University agricultural economists, on the changing role of capital and equipment in agricultural production, has special significance for readers of this journal: "As the general level of efficiency increases in the nation, wage rates will continue to rise relative to prices of the products of labor. This will mean that wage rates will rise more than equipment prices and continue to make it profitable to substitute more and more machinery for labor both on the farm and in the factory. Present types of equipment will be improved and new equipment to perform tasks now performed by human labor will be developed and put into profitable use by farmers. Equipment will play a relatively increasing role in agricultural production." Note especially that "present . . . equipment will be improved and new equipment . . . developed" - of course, through the efforts and skill of engineers, an exceedingly important key to the continued spiraling of progressive trends.

**"NOW FARMERS ARE PEOPLE, TOO" - WITH FARM MECHANIZATION** The quotes are the title of the Timken advertisement on the back cover of this issue - where, incidentally, Timken ads have regularly appeared since the April, 1924, issue - a third of a century. The ad points up the fact that farm mechanization now helps "2,000,000 fewer farmers feed 30,000,000 more people - just since 1940." . . . Well-engineered tractors, implements, machines - with anti-friction bearings and other efficiency-improving components incorporated into their designs - have made possible the tremendous strides in mechanization. The substitution of mechanical for muscle power has lifted grueling drudgery from the backs of both men and animals - all largely the result of a well-balanced combination of engineering genius with manufacturing know-how - the kind of "Better-ness" the copy-writer who prepared the Timken ad must have had in mind.

DRAINAGE RESEARCH FINDINGS HELP SIMPLIFY TILE SYSTEMS

In repeated tests at the University of Minnesota hydraulic research laboratory, Philip W. Manson, U of M agricultural engineer, in collaboration with USDA research engineers, has found it possible to put lateral junctions in draintile lines at 90-deg angles and get just as good drainage (no interruption to water flow) as with 30 or 45-deg junctions. Placing the junctions at right angles does away with the need of curving the lateral lines and the resulting gaps between individual tile sections which have always made draintile installations more complicated and expensive. . . . In the fact that tile drainage can now be made more efficient and economical, the draintile folks will find a good selling argument for using more of it.

A PROMISING FUTURE FOR PLASTIC PIPE ON FARMS

There is increasing indication that the farm market is much interested in the potential use of plastic pipe on farms. Agricultural engineers have been quick to recognize its advantages for a number of uses and to give it their enthusiastic endorsement. . . . In the first place, installation is greatly simplified, which more than offsets its slightly higher cost as compared with galvanized iron pipe. Also, unlike the latter, it will not rupture in case water freezes in it. Proof against corrosion is another important advantage of plastic pipe. . . . Possibilities in the variety and amount of application in agriculture of both plastic pipe and sheets challenge the imagination. More and more agricultural engineers are now giving attention to ways and means of developing the promising farm market potential for these products. Indeed, we may now be witnessing the emergence of the "plastic age" in agriculture.

PRESERVING THE HISTORY OF FARM MECHANIZATION

For some time F. Hal Higgins, 30 years a member of ASAE, has been lamenting the lack of appreciation on the part of so many agricultural engineers of the importance of preserving records and typical examples of those things that have contributed to making farm mechanization history. For a quarter century, Hal has been a lone wolf in his patient efforts to dig out this history. His urgent plea is that every state college ag engineering department enlist the interest of their respective history departments in gathering the great variety of materials that go to make up each state's farm mechanization history. . . . He points out that the whole USA is becoming more and more history conscious, but thinks ag engineers are lagging and urges that they get interested in digging into old records, catalogs, photos, letters, scrapbooks, clippings, magazines, etc, etc, for the gems of history worth preserving. . . . The idea merits general response. For one thing, it's a good way to increase the indebtedness of posterity to this generation.

IRRIGATION - SPRINKLER AND SURFACE - A COMPARISON OF RESULTS

A University of Nebraska agricultural engineer, B. R. Somerhalder, reports that, to accomplish the same results, sprinkler irrigation required one-seventh less water than surface irrigation. On the basis of three-year tests on alfalfa plots, the annual requirement was 27.8 inches of water for sprinkler irrigation and 32.2 inches for surface irrigation. In areas where both forms of irrigation may be at all competitive, these results will be significant both to irrigationists and to manufacturers of sprinkler irrigation equipment.

**The belt drive p. t. o. stood still . . .**

An early-day tractor—International Harvester.

Minneapolis-Moline built this one.

**until the splined shaft p. t. o. took over . . .**

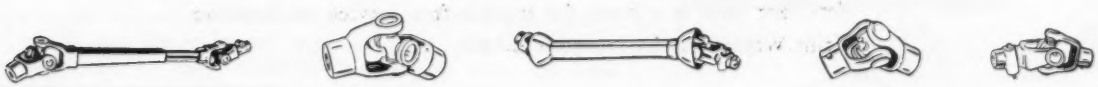
A late model Allis-Chalmers.

**. . . providing flexible power transmission to all implements equipped with adaptable**

# BLOOD BROTHERS Jointed Drive Lines

History was made when engineers first replaced the "pulley p.t.o." with the universal-jointed shaft. For this concept of flexible power transmission was the key to Progress. Implements that had, until then, remained stationary in the fields now moved forward. And the whole implement industry moved forward too—building innumerable new, better machines driven through universally adaptable, flexible drive line assemblies. Working with the manufacturers, Blood Brothers has kept pace—by building stronger, better drive lines for every farm implement requirement. If *you* build implements, consult Blood Brothers for helpful cooperation.

**FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED**



**BLOOD BROTHERS MACHINE DIVISION**

*ROCKWELL SPRING AND AXLE COMPANY*

**ALLEGAN, MICHIGAN**

**UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES**



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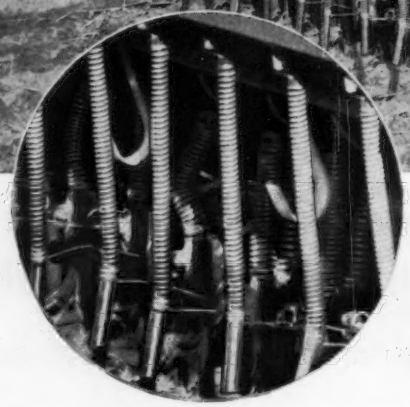


# Allis-Chalmers Stretches Farm Dollars with Thermoid Rubber Products

On "ALL-CROP" Drills, built by Allis-Chalmers, with *Thermoid Band Seeders* attached, farmers save up to 50% on seed costs, and get 28% more yield. Accurate seed placement *behind* the disc openers insures close-to-surface germination. Increased yields of hardier, more drought-resistant grasses and legumes have been reported—in many cases at savings of more than $5.00 an acre on seed costs alone! And, by using this method, fertilizer feeds the seeds—not the weeds!

"ALL-CROP" Drills also feature *Thermoid Fertilizer Hose*, with an exclusive, extremely flexible design that won't collapse from wear or clog from corrosion. Tests prove Thermoid Fertilizer Hose lasts three times longer than steel tubes. Chemicals corrode steel but not rubber! Along with the Band Seeder, the hose assures efficient use of fertilizer.

Bandseeding is a must for better grassland farming. Rubber fertilizer hose is a must for trouble-free service on fertilizer drills. Write to us for complete details.

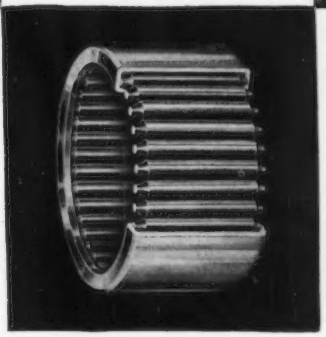
***Stretch farm dollars with Thermoid Rubber***

**Thermoid**

**Farm Products Division**
**Thermoid Co., Trenton, N.J.**

Massey-Harris-Ferguson, Inc. uses six Torrington Needle Bearings in the F-EO-20 and F-EO-35 Dyna-Balance Mowers for ease of assembly, compactness, smooth operation and long service life.

# How to cut a swath— faster and smoother



First successful high-speed, vibrationless mower offered the American farmer is the Ferguson Dyna-Balance Mower. By eliminating vibration, operator fatigue is reduced, service life extended and production potential increased.

To keep friction low and operation smooth, six Torrington Needle Bearings are used on knife head and lever pivot pins. They contribute to easy assembly, light weight and compactness while providing maximum load capacity and long service life.

Such features have led to the extensive use of Torrington Needle Bearings in all types of farm and automotive equipment. If we can be of service to you in engineering Torrington Needle Bearings into your equipment, please call on your Torrington representative. *The Torrington Company,* Torrington, Conn. — and South Bend 21, Ind.

Golden Anniversary 1907 ASAE 1957 AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

**TORRINGTON BEARINGS**

*District Offices and Distributors in Principal Cities of United States and Canada*

**NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE ROLLERS • BALL • THRUST**



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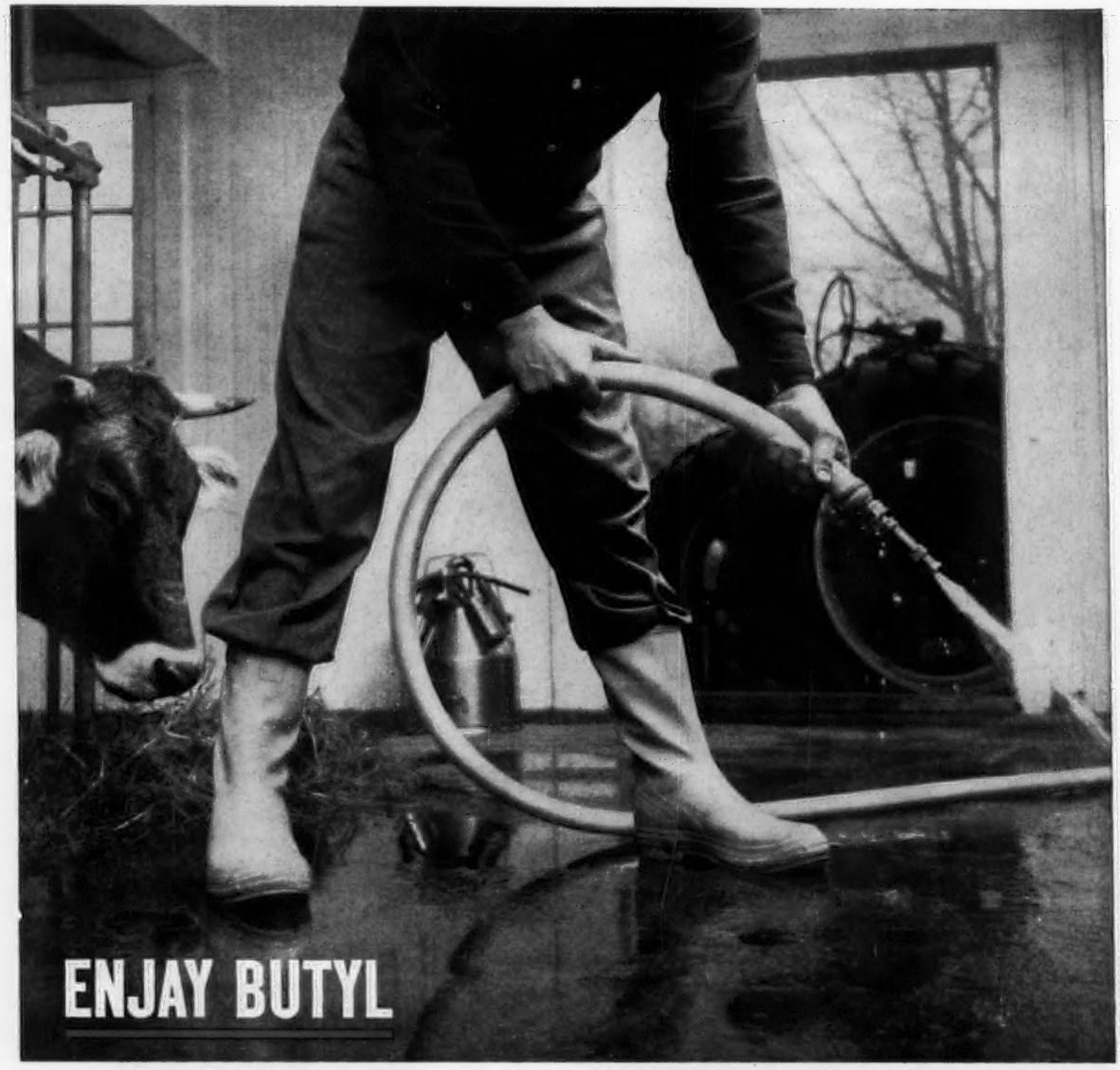



# *all-purpose wonder rubber* OFFERS TRIPLE VALUE

Performance! Versatility! Economy! In all three, Enjay Butyl is the world's outstanding rubber value. In a wide variety of applications, Enjay Butyl stands *unmatched* in its resistance to deterioration caused by animal and vegetable fats, chemicals, hot and cold water . . . properties that make Butyl-made products *outstanding* performers.

Dairy boots, creamery hose, wading pools, hot material conveyor belts . . . in these and a wide variety of other products, Enjay Butyl out-performs and out-lasts all other types of rubber, synthetic *or* natural. Low-in-cost and immediately available in a grade tailor-made for *your* product, Enjay Butyl is *the* rubber to boost performance and cut costs. For further information, and for expert technical assistance, contact the Enjay Company.

ENJAY

*Pioneer in Petrochemicals*

**ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.**

*Akron • Boston • Chicago • Los Angeles • New Orleans • Tulsa*

ENJAY BUTYL

Enjay Butyl is the greatest rubber value in the world...the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

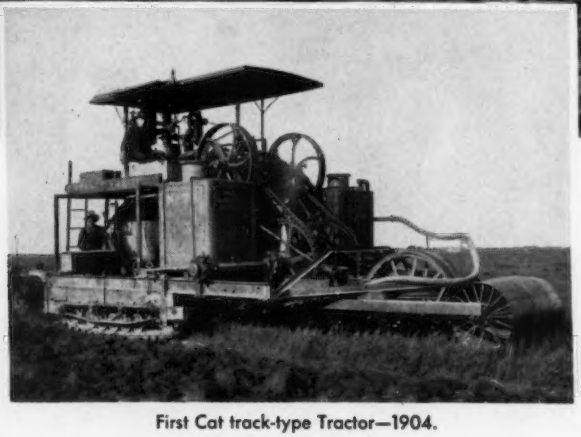
# Two new ideas that helped change the face of the earth

Two significant events were developing almost simultaneously about 50 years ago.

One new idea was the official founding of the ASAE in 1907. The other was the development of the CAT* track-type Tractor in 1904. Together, these ideas have helped change the face of the earth. Together, they have helped make possible American agriculture's transition from muscle and sweat to machines. *Yesterday:* pioneers—*Today:* leaders—*Tomorrow:* limitless opportunities.

Caterpillar Tractor Co., Peoria, Ill., U.S.A.

Golden Anniversary
1907 ASAE 1957
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS



First Cat track-type Tractor—1904.

CATERPILLAR*
*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

PARTNERS IN PROGRESS
ASAE—CATERPILLAR

# DAYTON DOUBLE COG-BELT*
# Allis Chalmers

## Infinite choice of speeds — from 1½ to 14¾ mph — means

A dual transmission system permits fast, accurate speed changes to suit any ground or crop condition encountered by the new Gleaner Baldwin combine.

Stopping, starting, and speed range changes are made through the automotive-type three-speed and reverse transmission while a variable speed sheave remains unchanged. Once the range is selected, a hydraulic control varies the speed infinitely between 1½ to 3¼ mph in low, 3 to 6½ mph in intermediate, and 6½ to 14¾ mph in high gear.

At the heart of this system is a Dayton Double Cog-Belt* which transmits power from the engine — mounted high in the combine — to the hydraulically controlled variable speed sheave.

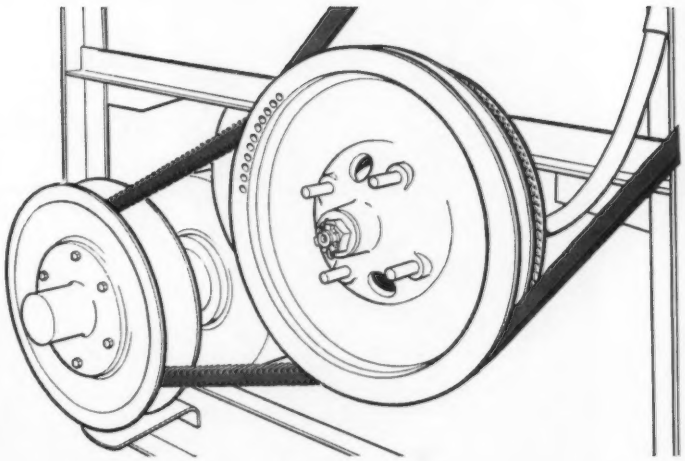
Dayton recommended their Double Cog-Belt because (1) the die-cut raw edges would transmit the torque from the engine without slipping; (2) it resists squashing under heavy loads; and (3) it has the high degree of flexibility required when operating with small pitch diameters at

# Drives New Dual Transmission System

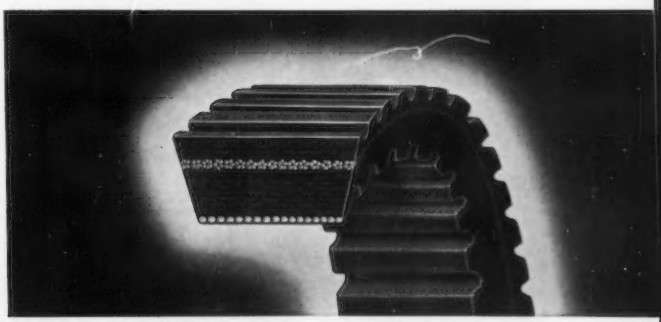
## faster combining with this new Gleaner Baldwin Unit

input speeds of nearly 2,000 r.p.m. In extensive field tests, the Dayton Double Cog-Belt met every requirement and was accepted as production material.

Next time you have a power transmission problem, consult a Dayton Agricultural Engineer. He can recommend a suitable V-Belt from Dayton's complete line or engineer a special belt for your exact requirements. To contact him, write Dayton Rubber Company, Agricultural O.E.M. Division, Dayton, Ohio.



Dayton Double Cog-Belts are the lowest cost, simplest, and most easily maintained form of variable speed transmission.



Especially designed for use with small diameter sheaves, exclusive Dayton Double Cog-Belts have die-cut edges for positive gripping and extreme cross-wise rigidity to prevent squashing and distortion.

*T. M. © D. R. 1957

**Dayton Rubber**

**First in Agricultural V-Belts**

**Agricultural Sales Engineers in Atlanta, Chicago, Cleveland, Dallas, Dayton, Moline, New York, San Francisco and St. Louis**

**why Crucible *LaBelle* discs stay sharp longer**

Sharp edges mean better discing performance. And the secret of a sharp, long-lasting edge is in the *steel.*

Crucible LaBelle discs are the only ones prescription-made by *steelmen* to the right combination of toughness and hardness. And they are tempered to resist damage by rocks or roots in the field.

On new equipment – or for replacements – choose LaBelle discs. They're made for all makes of plows and harrows, and for all soil conditions. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pennsylvania.*

A Massey-Harris MH60 Hydramic Control Disc Harrow, factory-equipped with Crucible LaBelle discs.

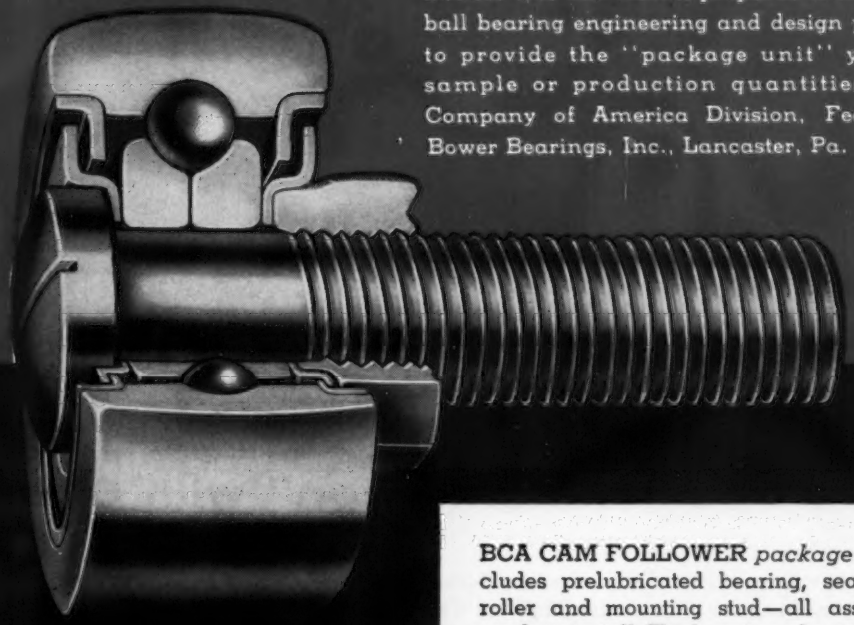
**CRUCIBLE** first name in special purpose steels

**Crucible Steel Company of America**

# BCA "package units"

## . . . proven time-savers in factory and field

Design and service tested, BCA *package units* simplify production line installation . . . bring ball bearing costs down to practical levels. And rugged construction plus effective sealing assures long and trouble-free use. BCA is prepared to help with your ball bearing engineering and design problems . . . to provide the "package unit" you need in sample or production quantities. Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.



**BCA CAM FOLLOWER** *package unit* includes prelubricated bearing, seals, cam roller and mounting stud—all assembled, ready to install. Thick-sectioned outer race is case hardened to withstand shock and is slightly crowned to assure better contact with cam. 37 different designs available with labyrinth or contact seals to meet your "package unit" needs.

***FREE...*** BCA's "Engineering Handbook." Available to engineers without cost. Write on your company letterhead.

BCA Division

Federal-Mogul-Bower Bearings, Inc.

For more facts circle No. 21 on reply card

## *A big step toward Better Farm Power—*

## Talk "Power Transmission" with Clark

For more than half a century the engineering resources and creative energies of Clark Equipment have been focused on this Vital Area of machine performance: Engine Power Transmission.

Several manufacturers of agricultural, industrial and automotive equipment are sharing the rich benefits of that specialization: benefits such as *more work done, lower cost of doing it, greatly reduced maintenance, longer-lived equipment.* These sum up neatly in "Better Value for a Dollar."

Among equipment builders cashing those benefits is Clark itself, through its own end-product machines: fork-lift trucks, straddle carriers, industrial towing tractors and powered hand-trucks for materials handling; and tractor shovels, turbo-dozers and excavator cranes for the construction industry. No user is more appreciative of those benefits than Clark, nor recognizes them more clearly as inevitable results of unique experience and straight thinking.

For this is the new approach by modern engineering: To think not of component units, no matter how skilfully assembled—but rather in terms of a complete, integrated power-train of functional design to do a bigger job better and cheaper.

You can say this now of a growing number of modern machines—our own and others, for agricultural and industrial uses:

- From engine flywheel to point of torque application—power train designed and manufactured by Clark Equipment.

It's a vital step, yet easy, toward basic improvement of your product—and costs not a cent: Arrange to talk "Power Transmission" with the engineers of Clark. Write a letter.

CLARK® EQUIPMENT

**CLARK EQUIPMENT COMPANY**
Automotive Division
JACKSON 1, MICHIGAN

backed by a 50-year
record for dependability . . .

★ ★ ★ ★

# STEWART-WARNER

## INSTRUMENTS AND GAUGES

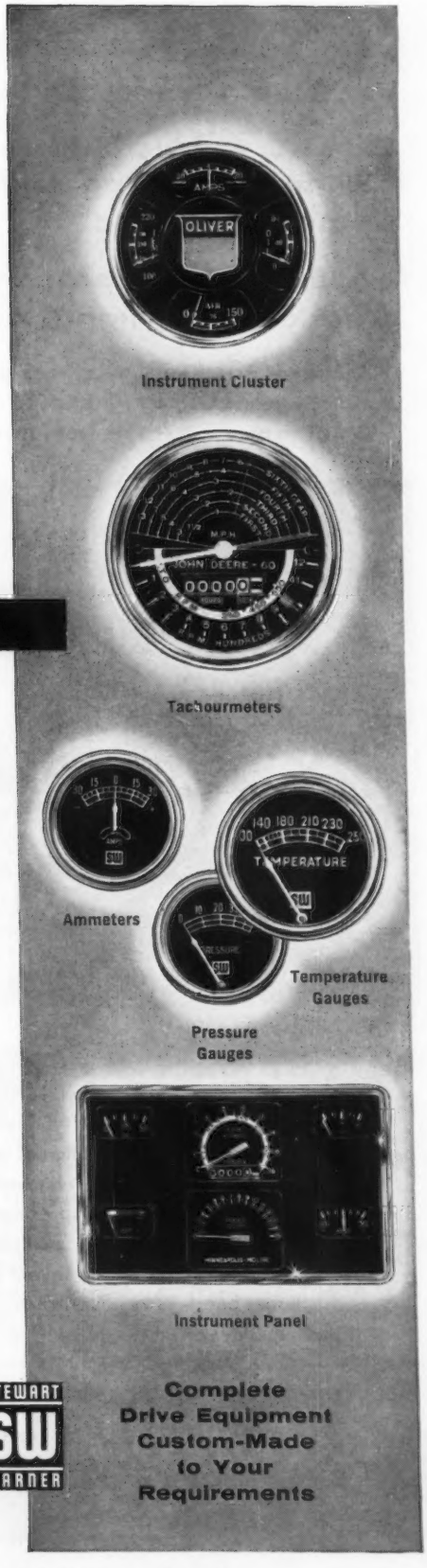
**including complete drive equipment—
designed, engineered and manufactured
to your specifications**

. . . all from one manufacturing source!

For half a century, Stewart-Warner has made quality instruments and gauges for agricultural applications.

Many leading implement manufacturers capitalize on this unmatched experience and know-how by specifying Stewart-Warner equipment *exclusively.*

The complete Stewart-Warner line offers you a wide choice of gauges, speedometers, tachometers, and tachourmeters. Entire panels can be custom-made to your own specification. Everything you need for a complete installation—including flexible shafts, gears, and adapters. Let Stewart-Warner supply *all* your instrument needs—*from one dependable manufacturing source.*




***For further information, write:***

**STEWART-WARNER**

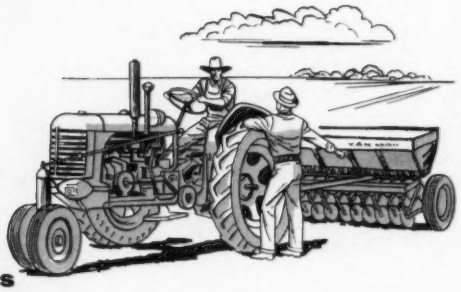
**Dept. V-67, Original Equipment Sales**
**1840 Diversey Parkway, Chicago 14, Illinois**

STEWART SW WARNER

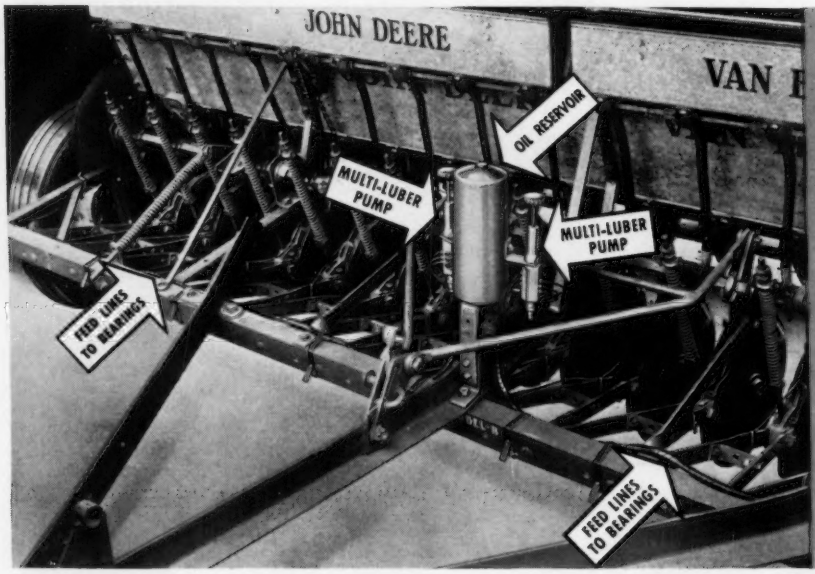
**Complete Drive Equipment Custom-Made to Your Requirements**

# *Lincoln* pushbutton power lubrication for farm implements

- Eliminates oiling and greasing time in the field
- Assures more productive work per daylight hour



**Assures Positive Pressure Lubrication in Seconds . . . Extends Bearing Life . . . Increases Machine Efficiency . . . Pays for Itself in One Season**




**Disk bearing life for John Deere Van Brunt Company Grain Drills is infinitely prolonged through metered positive pressure lubrication to each bearing. Lincoln Multi-Luber Systems save labor by eliminating need for individual lubrication of furrow openers . . . save time and trouble by using same oil as used in the tractor crankcase.**

## *easy to use . . . simple to install . . . precision built to last!*

Lincoln Multi-Luber* power lubrication system permits simultaneous lubrication of all bearings in seconds . . . on such farm equipment as corn pickers, combines, manure spreaders, mowers . . . any implement having multiple bearing points. Provides proper, frequent lubrication . . . flushes bearings as it lubricates . . . pays for itself quickly.

Either manually or power operated, the Multi-Luber System is an injector pump that dispenses measured amounts of oil from 12 outlet ports through sealed tubing, to the bearings. The net result is a sharp reduction in costly lubrication time . . . with overall improved field performance.

***Write today for full details!***

*Trade Name Registered

**Lincoln**
THE MOST TRUSTWORTHY NAME IN LUBRICATING EQUIPMENT

**LINCOLN ENGINEERING COMPANY**
*Division of The McNeil Machine & Engineering Co.*
5702-06 Natural Bridge Avenue • St. Louis 20, Missouri

*Kaiser Aluminum Congratulates*

# THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

*on their Golden Anniversary Year*

**50 years** of agricultural progress in research, design and development...

**50 years** marked by a tremendous revolution in farm production through engineering skill and modern manufacturing techniques...

**50 years** of progress made possible with new developments in power and machinery, irrigation and drainage, soil erosion, farm buildings, and rural electrification... all brought about by the creative thinking and pioneering of agricultural engineers.

And in the future, the Kaiser Aluminum Agricultural Research Service will continue to work closely with agricultural engineers to assist them in creating new and better methods to increase farm efficiency and production.

**Kaiser Aluminum** *the bright star of metals*



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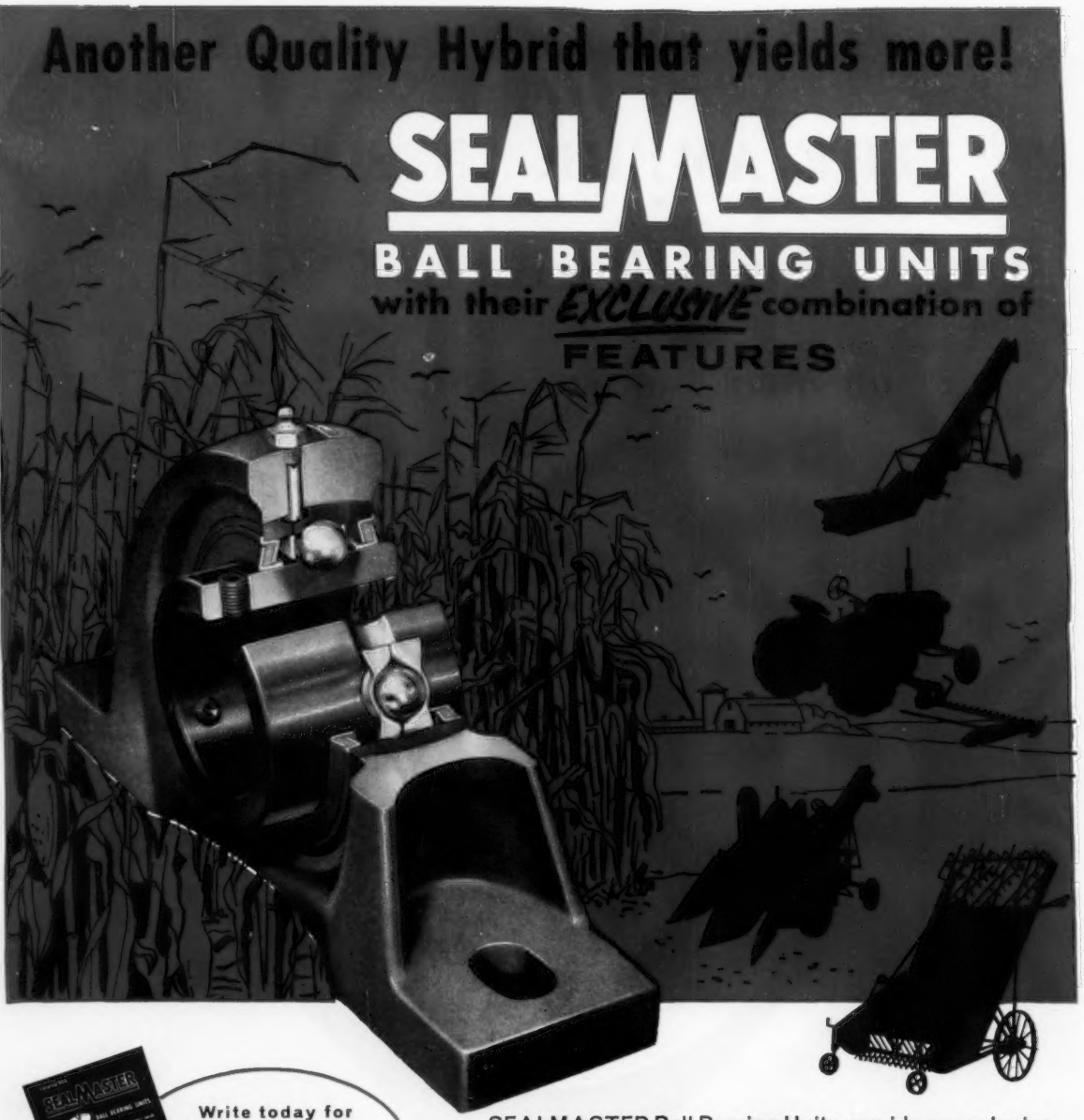
# Another Quality Hybrid that yields more!

# SEALMASTER

## BALL BEARING UNITS

with their *EXCLUSIVE* combination of

FEATURES



Write today for your Free copy of **SEALMASTER** Catalog 454.

SEALMASTER Ball Bearing Units provide an exclusive combination of features designed to provide higher standards of bearing performance and longer bearing life. They are based on sound engineering and rigid laboratory and field tests. They are important to the dependable operation of the farm machinery you build or sell. We will be happy to send you full information or have a SEALMASTER factory representative or stocking distributor call on you. It's quality you can't afford to overlook!

**SEALMASTER**

BALL BEARING UNITS

SEALMASTER BEARINGS, A DIVISION OF STEPHENS-ADAMSON MFG. CO. • Ridgeway Ave., Aurora, Ill.

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# RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

## *Technical-ities*

By John S. Davey

### Nuts — their use and abuse

With bolts tightened to high load levels, nut performance becomes critical.

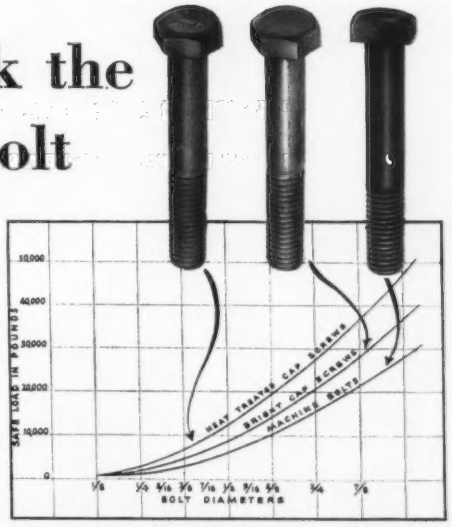
A nut produces bolt tension by rotating and advancing on the bolt threads. To do this, there must be a mating condition of threads, which is influenced by thread lead. Lead is a matter of tolerance only before bolt is stressed. When tightened, the nut is then under compression and threads tend to contract; the bolt is in tension, and threads tend to stretch. Lead of thread is affected—elastically *before* yield point, permanently *beyond* it.

This shortening of one lead and lengthening of the other has two effects. (1) The load distributes unequally along the threads (2) Torsion on bolt increases. Something has to give. For high tensile bolts especially, it is better for the nut to do so. A nut therefore should be soft enough so that it deforms plastically and compensates for off-lead. If it does, it *distributes* the load and can advance to increase tension.

**"SOFT" NUTS DO MOST JOBS**

"Soft" nuts do adjust more readily than hard ones under these severe conditions. While such nuts may not be as strong in shear as heat treated ones, the important point is the bolt tension they produce. As long as the nut can pull the bolt well into its plastic range, it is doing more than its share of the job.

## How to pick the right size bolt




When it comes to uniformity of dimension, quality of head and thread, and ease of assembly, all RB&W cold headed fasteners are the same. They differ mainly in tensile strength as shown here.

ALMOST all bolt and cap screw strength requirements can be satisfied from three types of *standard* fasteners without recourse to costly special alloys. In the widely used middle range of sizes, the problem is one of deciding which makes the best joint, or which proves the most economical for the job.

**MORE FOR LESS**

Suppose, for example, you need a bolt safe for 20,000 pounds of loading. As the chart shows, you could use an RB&W ⅞" square-head bolt, a ¾" bright cap screw, or a ⅝" heat treated one.

If you have a lot of holes to fill, use the larger, lower strength fasteners. But to cut down number of bolts, or their size (and therefore cost), go to the higher tensiles. However you gain nothing if you don't tighten high tensile bolts to their full strength.

**HOW COSTS COMPARE**

In terms of holding power: For each $1.00 in high tensile bolts, it costs $1.50 to provide equivalent clamping force with bright cap screws; or $1.65 with machine bolts.

For more suggestions on fastener economy or for copy of above curves, write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y.

**Plants at:** Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

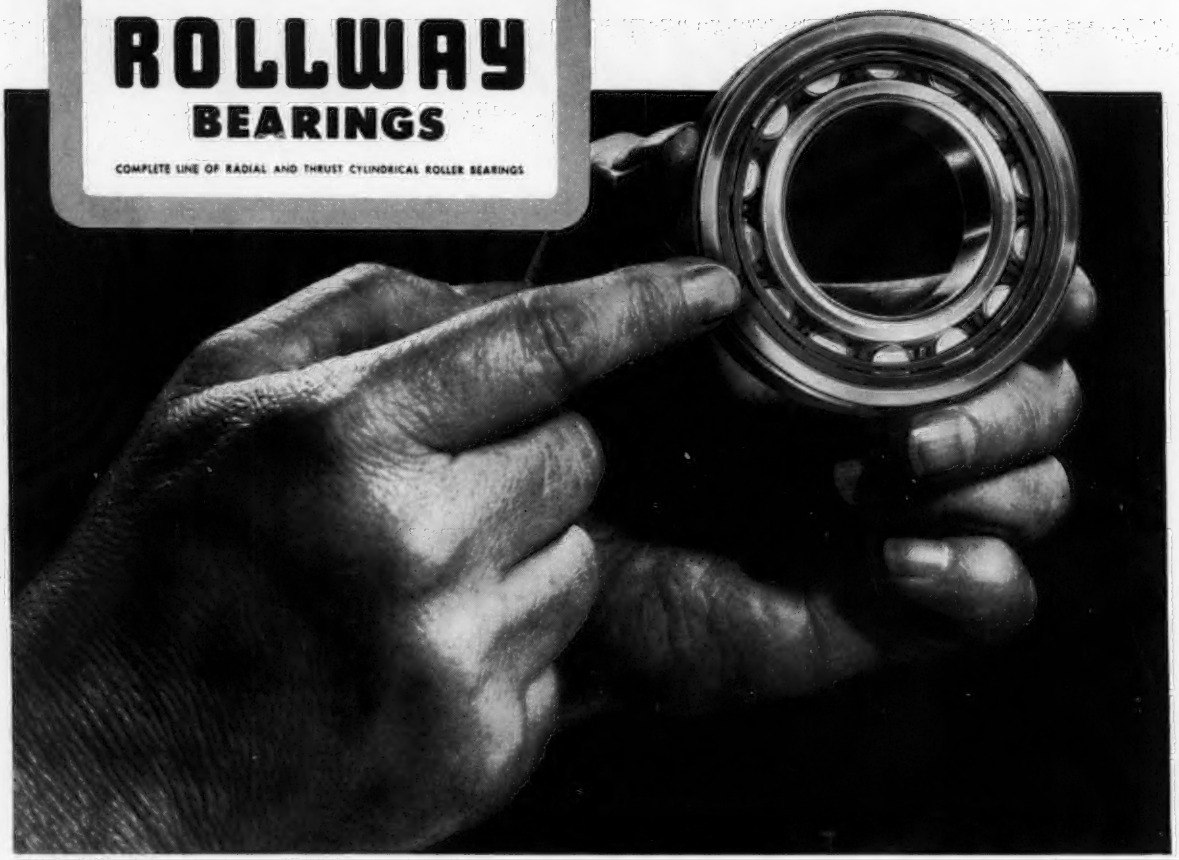
## Spin-Lock Nuts dig in to stay tight

The photograph shows the many hardened "anchors" on the flange of a Spin-Lock Nut. These "ratchet-action" teeth require 20% more torque to loosen than to tighten. They bite in as the nut turns down on its seat. Like Spin-Lock Screws, these nuts can stay put in products subject to vibration and cyclic temperature variations. Send for bulletin.


For more facts circle No. 24 on reply card

# ROLLWAY BEARINGS

COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS



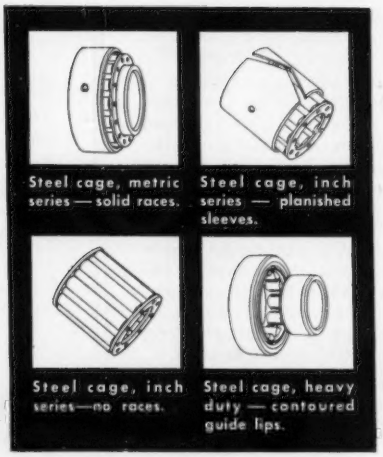
## ☐ TRUE or ☐ FALSE ECONOMY in Farm Implement Bearings?

✓ Meeting a cost-line by "saving" too much in such vital spots as bearings runs the risk of customer kickbacks. On the other hand, no engineer wants to specify bearings with three lives where one will do adequately.

There's truly *balanced economy* in Rollway's low-cost, quickly assembled steel-cage bearings. They are designed and built for farm service, farm maintenance and storage. They are priced in line with your cost requirements. The economies of automatic machinery and mass production permit finer engineering, materials and workmanship.

This is especially true of Tru-Rol, a bearing engineered for heavy-duty tractor applications . . . above-average efficiency at no extra cost . . . and free rolling qualities approaching that of bronze-separator types.

Let our engineers tell you about Rollway steel-cage roller bearings that will last as long as the implement or tractor. ROLLWAY BEARING CO., INC., Syracuse, N. Y.



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Steel cage, heavy duty — contoured guide lips.

• Our engineers will gladly work with you on your bearing problems. Confidential consultation. No charge—no obligation.

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# AGRICULTURAL MACHINERY NEWS

LATEST PROPERTY AND APPLICATION DATA ON

ZYTEL® nylon resin

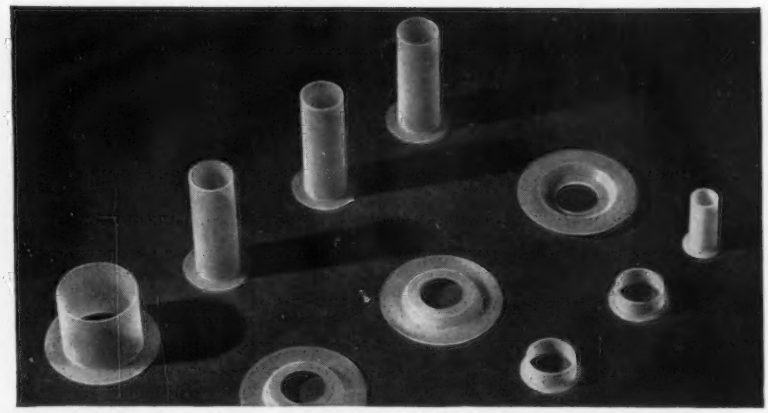
# Bearings and bushings of ZYTEL® nylon resin are abrasion-resistant ... need little or no lubrication

Tough, durable parts for agricultural machines made from Du Pont ZYTEL nylon resin stand up to rugged field work and often outperform metal parts they replace.

For instance, both gears and sleeve bearings of ZYTEL, tested in the presence of abrasive materials such as sand, outwear metal components by far. The load-carrying ability and temperature range of ZYTEL are approximately those of babbitt, with considerably better abrasion resistance.

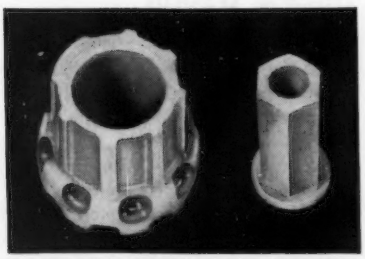
Under light loads, little or no lubrication is required for parts of ZYTEL. Operating with lubricant, simple sleeve bearings can support loads up to 1,000 lbs. per sq. in. at rubbing velocities up to 500 ft. per min. In one case, with only an initial lubrication, a bearing operated for 41 days without increase in temperature or torque.

Because of the resilience of the material, parts made of ZYTEL are quiet in operation, often damping or preventing the transmission of vibration to other components. Bearings of ZYTEL are resistant to pound-out. And components with thin walls, such as bushings, have high strength. Intricate shapes can be produced rapidly and economically to close dimensions by injection molding. And ZYTEL is rated for intermittent operation up to 250°F. For continuous operation at such elevated temperatures, heat-stabilized grades are available.

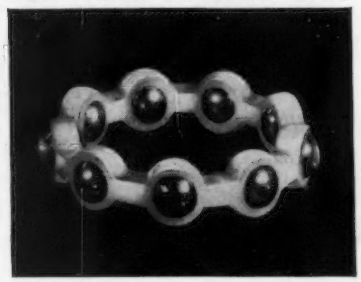


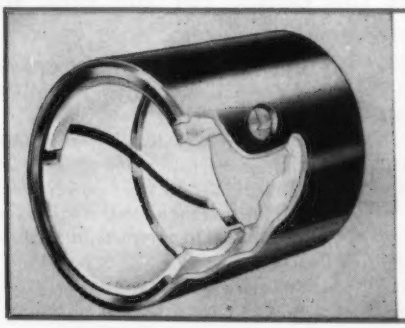
These brake-pedal bushings and window crank-handle bearing plates are made of ZYTEL. The parts give smooth, quiet operation and provide long-wearing bearing surfaces which, after assembly, do not have to be lubricated for the life of the vehicle.

Du Pont ZYTEL may be exactly the material you need to make hard-working machine parts. Send the coupon for free booklet. It contains scores of product ideas, showing how Du Pont ZYTEL has solved a variety of design problems.



Bearings of ZYTEL nylon resin shown above and ball retainer (below) feature excellent abrasion resistance, light weight, toughness in thin sections, heat resistance and resiliency.





**UNIQUE BEARING** utilizes a free-floating liner of Du Pont ZYTEL in a thin-walled sleeve of steel. This combination results in lower friction, quiet operation and reduced weight. Very often, lubrication requirements are satisfied when bearing runs in contact with liquids such as water or gasoline. (The bearing illustrated is one of many types of standard Nylined Bearings manufactured by Thomson Industries, Inc., Manhasset, N. Y.)

**SEND FOR INFORMATION**

Mail this coupon for additional property and application data on Du Pont ZYTEL nylon resin.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
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## —making the job easier for the man who rides a tractor

Power steering is every bit as desirable for farm tractors as it is for passenger cars—*and for more and better reasons.*

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For example, power steering eliminates wheel fight and shock even over the roughest ground; it permits the tractor to be controlled by simply "pointing" where the driver wants it to go.

Also, short turns become an easy, one-hand job even when the tractor is standing still.

Any way you look at it, power steering saves time as well as work, and that's exactly why power steering on farm tractors is destined to be the next step forward in farming efficiency.

Bendix* Power Steering is a performance-proven product designed and engineered by Bendix, foremost producer of power steering and brakes for the automotive industry.

It is used with a conventional steering gear and is adaptable to existing steering linkage, permitting tractor manufacturers to make production-line installations without costly or extensive engineering changes.

Manufacturers interested in adding Bendix Power Steering to their present list of sales features are invited to write for further details to BENDIX PRODUCTS DIVISION, SOUTH BEND, INDIANA. *REG. U.S. PAT. OFF.

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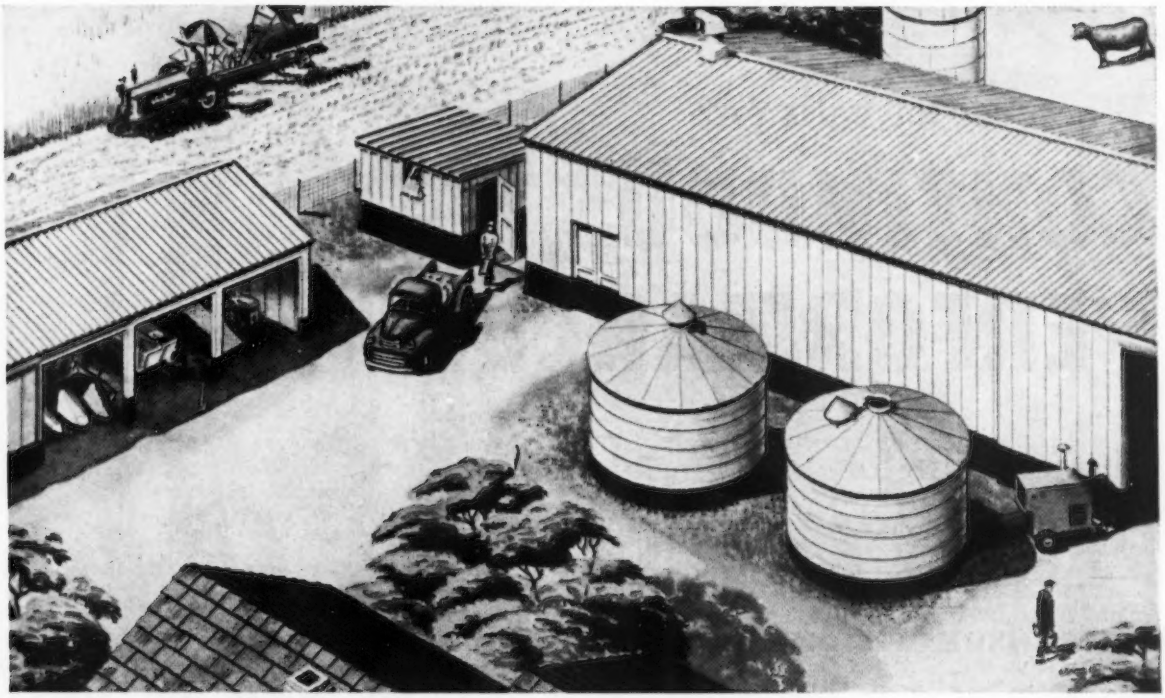

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**Applications:** Combines, corn pickers, elevators, stock watering tanks, hog and poultry equipment, and farm buildings.

ZINCGRIP PAINTGRIP®—ZINCGRIP steel that is mill Bonderized for immediate painting and long paint life.
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ALUMINIZED STEEL® Type 1—Continuous hot-dip aluminum coated steel with excellent resistance to a combination of heat and corrosion.
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Golden Anniversary 1907 ASAE 1957 AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

**Congratulations to the American Society of Agricultural Engineers on their Golden Anniversary.**

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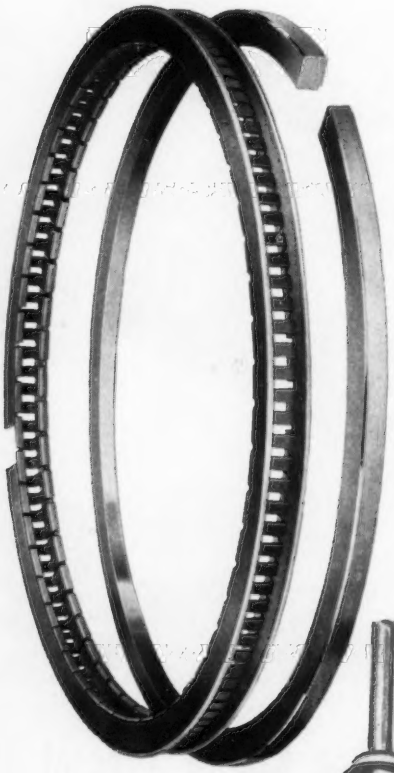

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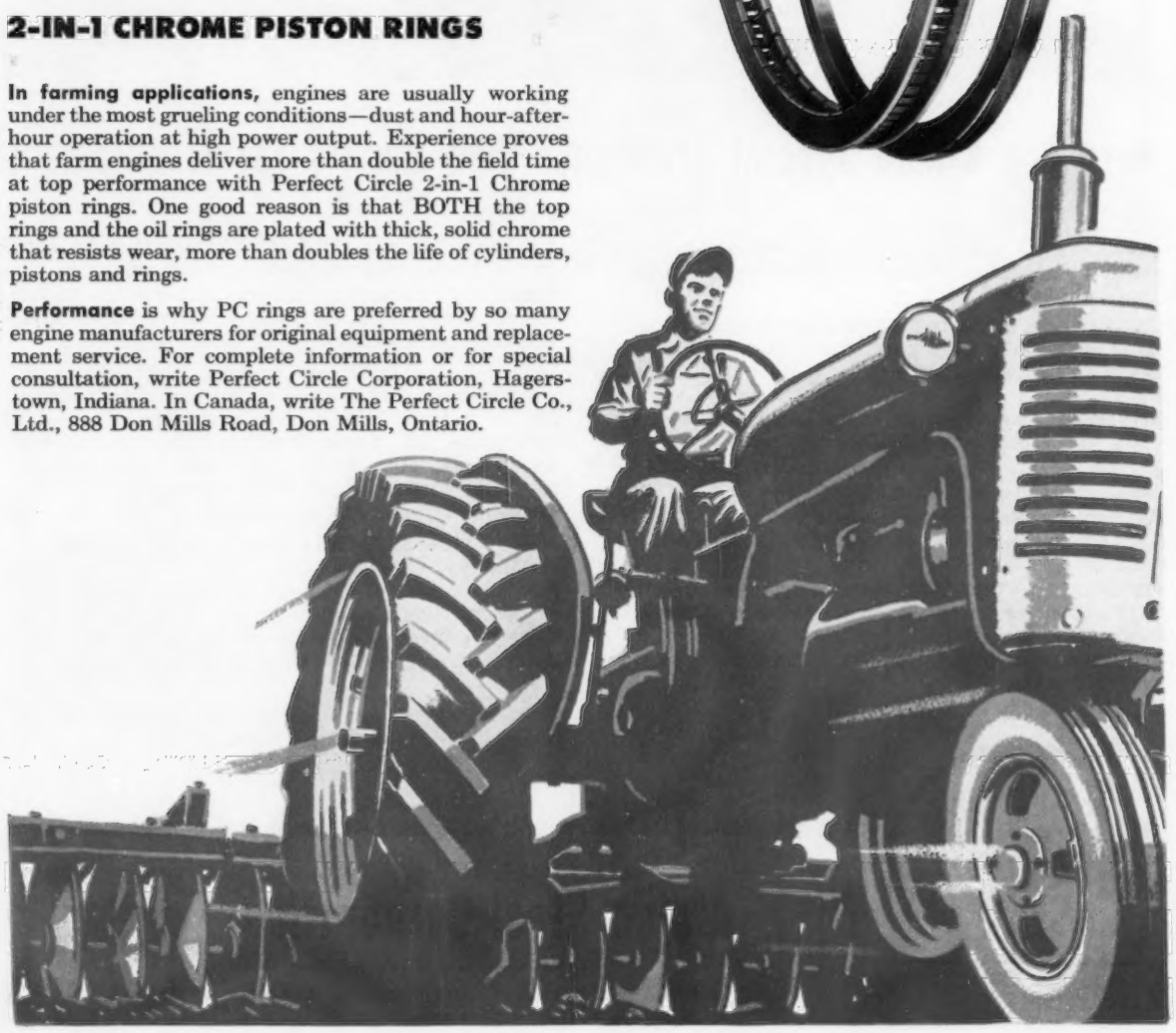
**Performance** is why PC rings are preferred by so many engine manufacturers for original equipment and replacement service. For complete information or for special consultation, write Perfect Circle Corporation, Hagerstown, Indiana. In Canada, write The Perfect Circle Co., Ltd., 888 Don Mills Road, Don Mills, Ontario.



Agricultural Engineering

June, 1957
Volume 38
Number 6

James Basselman, *Editor*

# The Engineer's Place in Agriculture

**Roy Bainer**
Fellow ASAE

THE passage of fifty years makes a mere ripple in the history of man. Yet during the past half-century, technology in agriculture has advanced more than in the entire history of the world. The impact of engineering on agriculture is felt in every walk of life. Without the contributions of agricultural engineers, the majority of our population would still be engaged in producing food and fiber. Little man power would be available for providing the services and producing the many items that contribute to America's high standard of living.

The motivating force in agricultural mechanization has been to save labor. Pressure to substitute the machine for manual labor has varied somewhat with economic conditions. For example, the national emergencies created by two world wars resulted in labor shortages and higher wage rates as well as a demand for increased agricultural production. These combined factors had a marked influence on the rate at which capital equipment was substituted for labor. The greatest acceleration in the substitution of capital for labor came during and immediately after World War II. In this 15-year period, for example, the number of tractors on farms tripled. The increase in motor trucks amounted to 170 percent, milking machines 320 percent, combines 400 percent, and the number of corn pickers increased six times. With this phenomenal increase in equipment, the production per farm worker practically doubled. According to Bottum and Dunbar*, this gain in production, on a percentage basis, was equivalent to that of the past 120 years.

ROY BAINER
50th President of ASAE, 1956-57

Some of the increased production realized during the past half-century must be credited to advances in non-engineering phases of agricultural technology such as better crop varieties, more effective use of fertilizers, fungicides, herbicides, and insecticides, and improved cultural practices. A major factor, however, has been the increased use of non-human energy, the development of more effective machines, and the timeliness of the field operations made possible by mechanical equipment.

Labor saving in agriculture at the production level does not tell the entire story. For example, to produce, merchandise, and deliver a one-row, spindle-type cotton picker requires a labor input of approximately 5000 man-hours. Furthermore, practically the entire cost of operating and maintaining the machine represents labor. In purchasing and operating such a machine, the farmer makes a prepayment on some relatively high-priced labor. Since this machine will do the work of 25 field laborers, he can show a net gain provided he uses the machine effectively and maintains it properly. All of the labor that goes into the machines the farmer buys and the many other materials and services he demands could well be classed as farm labor. In other words, the farmer-industry relationship is what actually produces the crops. It is difficult to determine where farm services end. An estimated 40 percent of the working force in this nation is engaged in supplying materials and equipment to agriculture and in producing, processing, transporting, and merchandising food and fiber.

Although no one will deny the great contributions made by the engineer to agriculture, most will agree that there is much left for him to do. The production of such crops as the cereals and forages has been pretty well mechanized. On the other hand, complete mechanization of tree and vine crops, vegetables, and tobacco has offered a greater challenge to the engineer. These crops are difficult to mechanize because of the judgment and care generally required in such operations as pruning, thinning, and picking. The production of a 10-ton-per-acre crop of cling peaches, for example, requires about 300 man-hours of hand labor. More than two-thirds of this is used in harvesting.

Solving the more difficult problems of mechanization will depend upon team effort—team effort involving the engineer, the plant scientist, and the food technologist. The plant breeder can do much toward changing the characteristics of plants for easier handling by machine. Good examples in the past have been the development of dwarf varieties of sorghums, stormproof cotton, shatterproof small grains, hybrid corn varieties with less tendency to lodge, and monogerm sugar beet seed. Future developments for the plant breeder might well include the following: dwarf castor beans, canning tomatoes adapted to a once-over mechanical harvesting system, longer stems on grape clusters to better position them for mechan-

*(Continued on page 387)*

*Bottum, J. Carroll and J. O. Dunbar. The Business and Agricultural Outlook and Technological Developments. *Farm Equipment Institute Economic Newsletter*, 1957.

# ASAE — Its Founding and First Fifty Years

**Henry Giese**
Fellow ASAE

LATE in December of 1907, nearly fifty years ago, a small group of instructors met in Madison, Wisconsin, to discuss common problems and possibly to effect an organization which would enable the group to cooperate toward the improvement of their teaching. Out of the enthusiasm developed at the meeting came, rather unexpectedly, an engineering society, which now not only boasts a membership close to 5,000 but enjoys a professional prestige almost undreamed of by its founders. As Philip S. Rose, a charter member, has stated (4, 5)* "None of us could even guess what kind of a tree it was, or how big it would grow, when a few gathered together in Madison almost half a century ago. But as the years passed it grew strong and sturdy. It has the growth possibilities of a giant."

"Unfortunately, previous to the formation of the American Society of Agricultural Engineers these men enjoyed no special designation. They had no professional standing. There was no place where they might file a record of their achievements, no place where they could meet and discuss their professional problems."

Like the tree, however, the sudden appearance of growth does not mark the real beginning nor describe the factors responsible for its character. We cannot evaluate the significance of an accomplishment without consideration of those events preceding and conditions prevalent at the time. We cannot appreciate the vision and courage shown by those responsible for our organization without knowing the obstacles in their path.

The introduction of subjects related to engineering into the agricultural curricula was slow and gradual. The illustrations given do not necessarily represent the first nor most important, but may be typical of developments taking place in other institutions as well as in those mentioned.

The agricultural curriculum at the Farmers College at College Hill, Ohio, contained in 1852, the following subjects: drawing plans and elevations, mechanics, civil engineering and rural architecture. In 1861, the four-year agricultural curriculum at the Michigan Agricultural College provided for trigonometry, surveying, civil engineering, drawing and rural engineering.

An early use of the term, "agricultural engineer," was reported by John R. Haswell in AGRICULTURAL ENGINEERING (9:194): "In looking over a report for 1902 of the Department of Parks, City of New York, relative to Central Park, the following notation is found on page 10: 'In 1857 Mr. Olmstead was appointed superintendent to the Board, and George E. Waring, agricultural engineer'."

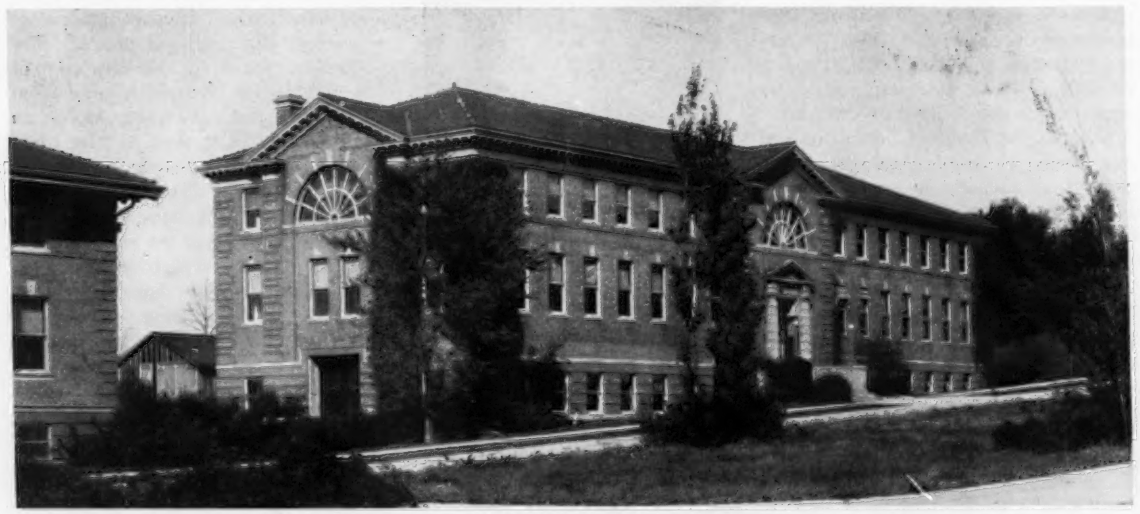
In the circular and catalogue of the officers and students of the Illinois Industrial University for 1868-69, a vacancy is shown for a professor of civil and rural engineering. In the same publication for 1870-71, Col. S. W. Shattuck was listed under the faculty as professor of agricultural engineering.

It is probable that the passage of the Land-Grant College Act in 1862 stimulated the listing of such subjects by its specification that colleges aided by the Act should teach "such branches of learning as are related to agriculture and the mechanic arts". It is not to be assumed, however, that

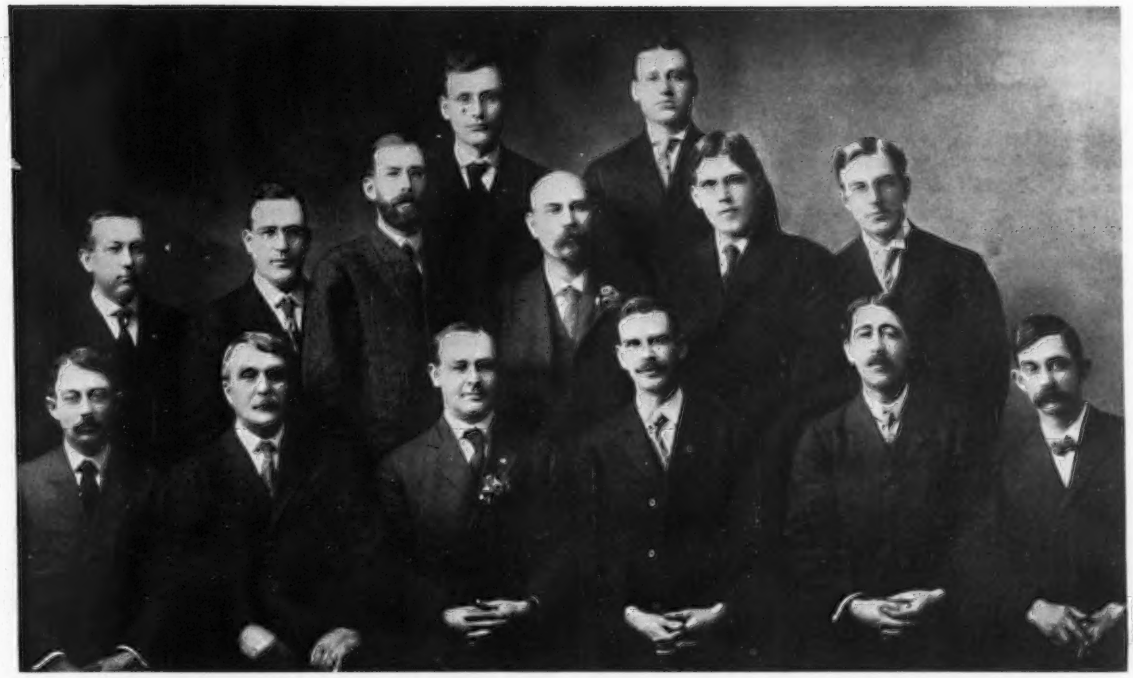
*Numbers in parentheses refer to the appended references.

Paper prepared expressly for the Golden Anniversary issue of AGRICULTURAL ENGINEERING.

The author—HENRY GIESE—is a professor of agricultural engineering at Iowa State College, Ames.



The agricultural engineering building at the University of Wisconsin, where the American Society of Agricultural Engineers was founded in 1907



This picture was taken at the organization meeting of the American Society of Agricultural Engineers, at Madison, Wisconsin, December 27 and 28, 1907. *(Left to right, front row)* J. W. Criswell, J. B. Parker, F. R. Crane, J. B. Davidson, P. S. Rose, H. M. Bainer; *(second row)* W. M. Nye, C. A. Ocock, H. W. Riley, John Evans, E. A. White, M. L. King; *(third row)* Everett W. Hamilton, Walter R. Block. Present at the meeting but not in the picture were L. W. Chase, B. B. Clarke, R. M. Dolve, J. M. Drew, A. O. Fox, Elmer W. Hamilton, Mr. Mallet, E. E. Parkinson, H. L. Russell, R. P. Teele, J. G. Wynn

the response was either immediate or extensive. Not only the public but also college administrators were slow in accepting the general idea that it was necessary or desirable for a farmer to attend college. Doubtless the lack of development of the science of agriculture contributed to that viewpoint. Perry G. Holden, who was appointed to the agricultural faculty at the University of Illinois in 1896, states in his memoirs: "I found a situation that was surprising and strange. Here was a University, with a College of Agriculture in what was considered the greatest agricultural state in the Union. The institution was in disgrace; many people seemed to have an antagonistic feeling toward the University, which had been started as an Industrial School and had been changed to a University. There were only a few hundred students in the Institution. In the College of Agriculture there were only sixteen students, all but three or four of these were mental cripples who had been thrown out of the other classes because they did not have the capacity to carry their subjects. In my senior class in agriculture, I had one poor, lone student. . . .

"Dr. Draper, a lawyer from New York City, had been elected president of the University. In accepting the position he said he wanted it distinctly understood that he would not be responsible for the success of the College of Agriculture, that he didn't believe that any young men who were going to farm would take a four year's course in agriculture, and that he didn't think it was necessary".

It is obvious, however, that scientific developments changed the situation very rapidly throughout the country shortly after the incident mentioned by Holden. In a letter to the author, Holden stated that the change in name of his department in the late 'nineties from Agricultural Physics to Agronomy, was to his knowledge, the first such use of the word "agronomy" in the United States. He believes, further, that his division into four subdepartments including "farm mechanics," may well have been the first such recognition of what later was to become "agricultural engineering."

According to Stout (6), "A subcollegiate school of agriculture was established in the University of Nebraska about 1895. In a catalog of the University published in June, 1896, it appears that the school faculty included O. V. P. Stout—agricultural engineering and C. R. Richards—practical mechanics. The name of J. Brownlee Davidson, instructor in forge work and farm machinery, appears in the catalog published in July, 1904."

The Iowa Agricultural College published a four-year curriculum in agriculture in 1871 containing freehand drawing, mechanics, farm engineering, road making, water supply, farm machinery and rural architecture. The subject matter content of the courses is not known. Shop courses were listed in the agricultural curriculum for the first time in 1891. Farm drainage appeared in 1892.

When, in 1902, Prof. Holden accepted the position as the first head of agronomy at the Iowa State College, he again divided his department into sections of crops, soils, farm mechanics and farm management. This brought the teaching of such related subjects into the agricultural division from engineering where they had been taught previously.

The 1902-03 catalog announced the availability of graduate courses in farm mechanics. Harry M. Bainer, the first

student to take advantage of this offering, received the degree of "master of science in agriculture" in 1904. His graduate thesis was entitled; "Investigation and Calibration of Corn Planters".

In 1903 when Clarence J. Zintheo was brought from the North Dakota Agricultural College to head the work in farm mechanics, course offerings were increased and a new building, believed to be the first agricultural engineering building in the United States, was constructed. In the fall of 1905, the name of the work having been changed to "agricultural engineering," J. Brownlee Davidson was invited to join the staff as assistant professor.

Davidson began immediately to expand and improve the offerings of his department. The 1906-07 college catalog announced; "The degree of Bachelor of Agricultural Engineering (B.A.E.) is given to students who have completed a four-year course in Civil, Mechanical or Electrical Engineering, followed by one year's prescribed work approved by the faculty in Agricultural Engineering and related sciences, under the rules and conditions governing work in other courses". As the first student to take advantage of this provision, Jacob E. Waggoner, was granted the degree in 1910, and the four-year curriculum in agricultural engineering was not announced until 1909, it is obvious that none of those persons attending the organization meeting in 1907 held degrees in agricultural engineering. It is probable, also, that not more than two had acquired the title by adoption.

The enthusiasm that J. B. Davidson, a mechanical engineering graduate from the University of Nebraska, was to manifest in his adopted field, and his eagerness to take advantage of the experiences of others, is shown by his visiting the University of Illinois and the Iowa State College shortly after graduation from the University of Nebraska. At Illinois, he met Charles A. Ocock, who was a temporary instructor while working for his master's degree. The regular instructor, Fred R. Crane, had not yet returned from his summer vacation. Davidson asked Ocock's opinion regarding the desirability of organizing a society of teachers in the farm mechanics field and suggested that he (Ocock) discuss the matter further with Mr. Crane. Not daunted by apparent lack of progress from his first efforts, Davidson persisted until in 1906 he succeeded in getting a meeting with Crane and Ocock at the University of Illinois. By this time, Davidson was located at the Iowa State College and Ocock at the University of Wisconsin. At that time, it was decided to attempt the organization of a national association and to hold the meeting in the new Agricultural Engineering building at the University of Wisconsin between Christmas and New Years in 1907. Davidson volunteered to write to the teachers of farm mechanics in the United States and Canada and also to some presidents of the large manufacturers of farm machinery and editors of farm implement magazines.

Rose (4) estimates that some 40 or 50 people attended the first meeting in Madison. Records show that the following were present:

Colorado Agricultural College, Fort Collins — Harry M. Bainer; J. W. Criswell

University of Illinois, Urbana — Fred R. Crane; Earl A. White

Purdue University, Lafayette, Ind.—William M. Nye

Iowa State College, Ames—J. Brownlee Davidson; Everett W. Hamilton; Matthew L. King

University of Minnesota, St. Paul—J. M. Drew

University of Nebraska, Lincoln—Leon W. Chase

Cornell University, Ithaca, N. Y. —Howard W. Riley

North Dakota Agricultural College, Fargo—Philip S. Rose; Robert M. Dolve

University of Wisconsin, Madison—Harry L. Russell (dean of agriculture); Charles A. Ocock; Franklin H. King; Walter R. Block

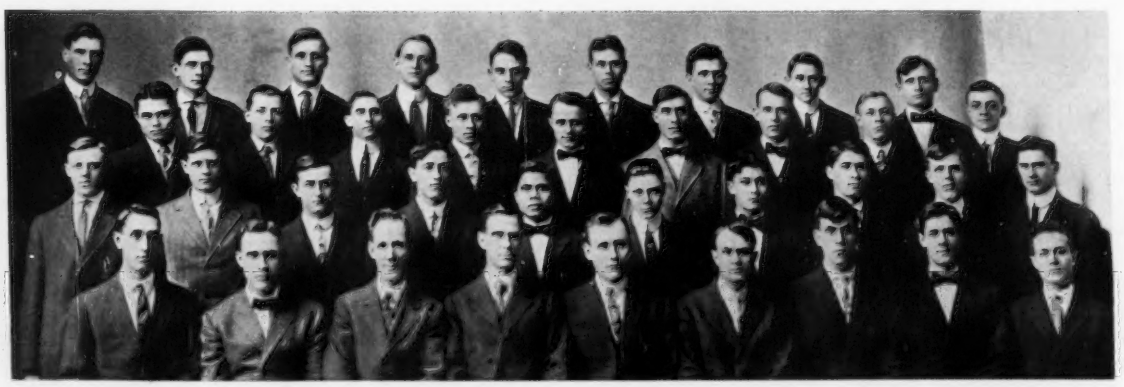
U. S. Department of Agriculture, Washington, D. C.—R. P. Teele

Ontario Agricultural College, Guelph—John Evans

*American Thresherman,* Madison—Bascom B. Clarke, editor; J. B. Parker; Edward E. Parkinson

*Canadian Thresherman,* Winnipeg — Elmer W. Hamilton, editor

Northern Electric Company, Madison—A. O. Fox, president; John G. Wynn; Mr. Mallet



The first Student Branch, organized in the Fall of 1910 at the Iowa State College and authorized by the ASAE in December of that year. (f) after a name indicates faculty member. *(Left to right, front row)* C. A. Norman, C. O. Alexander (f), D. W. Sylvester (f), J. B. Davidson (f), Everett W. Hamilton (f), E. Y. Cable (f), Martin, Feay, S. D. Snyder; *(second row)* G. W. Iverson, Wallace Ashby, M. A. R. Kelley, J. B. Kelley, Justion Valdez, G. I. McDermott, Filson, Daley, A. D. Longnecker, C. R. Hoff; *(third row)* G. L. Costigan, Cahow, B. R. Mullen, J. E. Waggoner, D. S. Wormley, Brooks, Clark, W. G. Kaiser, Hampe; *(top row)* H. B. Bliss, E. G. Welch, James Arentson, E. J. Van Meerten, S. Steigerwalt, Severson, F. G. Hodson, C. W. Stafford, Charles Cathcart

Others present but not named in the ASAE Transactions, have been designated as implement salesmen and sales executives.

The 1908 ASAE Transactions names the following as Charter Members:

| | |
|---|---|
| Harry M. Bainer | Everett W. Hamilton |
| William Boss | Matthew L. King |
| Leon Wilson Chase | William M. Nye |
| Bascom B. Clarke | Charles A. Ocock |
| Fred R. Crane | Howard W. Riley |
| J. B. Davidson | Philip S. Rose |
| Robert M. Dolve | Earl A. White |
| John Evans | John G. Wynn |
| Christian I. Gunness | |

Some recently uncovered evidence indicates that a peculiar mix-up, resulting from the presence of two registration cards bearing the name of E. W. Hamilton, may account for the omission of the name of Elmer W. Hamilton, editor of *Canadian Thresherman,* from the above list.

R. P. Teele, of the U.S. Department of Agriculture, apparently took an active part in the organization of the Society although his name does not appear on the membership list. He presented papers at both the first and second meetings. He was named chairman of a committee at the first meeting and elected second vice-president in 1908.

Further investigation regarding the addition of the names of Elmer W. Hamilton and R. P. Teele to the list of ASAE Charter Members is being conducted by the ASAE History Committee.

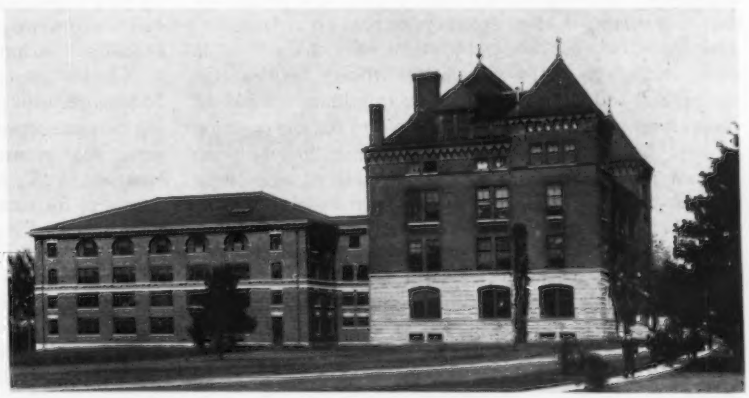
The opening sentence of the Secretary's report for the first meeting read: "The instructors in Agricultural Engineering met at Madison, Wisconsin." The thinking of those planning the meeting and the character of papers presented, all indicated that the primary purpose of the meeting was directed toward the improvement of the teaching of farm mechanics in the land-grant colleges. It soon became apparent, however, that this concept was quite inadequate, both as to the inclusion of interested parties and the delineation of the field encompassed. Perhaps the transitions which evolved from the enthusiasm of the meeting can be told best in the words of some of the Charter Members.

J. B. Davidson, in reviewing the meeting (1), stated: "It was a surprise to some that so many could be interested in coming to such a meeting. One gratifying development was the interest of the technical press and the commercial engineers; two electrical engineers attended the meeting and took active part. A review of the papers indicated how completely each member in attendance was engrossed in his own problems. The great benefit and profit which came from this first meeting, like others where men with a common interest gather, was the growth of enthusiasm for the work. Those present came feeling that they had a worthwhile job, but when they left the meeting, they were inspired crusaders with a mission.

"It was duly intended at the first meeting that some form of permanent organization should be formed, but there was division of opinion as to just what the objectives of the Society should be or who should comprise its membership. There were some who thought that, for the present, it would be better to modestly organize an association of instructors and thus perhaps avoid the criticism of the professional engineers. There were others, however, who thought the organization should represent a definite branch of the engineering profession with the avowed purpose of interesting all engineers concerned with the industry of Agriculture. The late Bascom B. Clarke, editor of the *American Thresherman,* after listening to the discussion, made one of the tempestuous speeches he was accustomed to deliver to threshermen's conventions, urging that Agricultural Engineering was a high calling and that those present should live up to their opportunity. B. B. won the group, and it was voted that it should be a society of engineers. Mr. Clarke, in my opinion, rendered a great service to the Society and his prophetic views have been fully proved by later developments."

The next step is ably described by Ocock, another Charter Member (2): "After the matter of settling the question of the nature of the Society and who should be members, the name came up for debate. There was considerable debate on this subject as Iowa and Wisconsin had already adopted the name 'Agricultural Engineering' as the name on their engineering buildings. But all the other colleges were rather hesitant about taking such a step.

"Dr. F. H. King (retired), who for many years had been connected with the Wisconsin College of Agriculture as head of the soil physics department, was in attendance and an attentive listener to the various arguments; asked for the floor, which was granted. He made a strong point of why the association should use the term 'agricultural' and pointed out that there should be no intrusion into the other fields of engineering, and any other term would be a misnomer. His speech was so impressive that it won the point,



This building, started in 1903 and completed in 1904, as an annex to the Agricultural Hall at the Iowa State College, is believed to have been the first building in the United States for use in teaching agricultural engineering subjects and for research in engineering problems related to agriculture. It cost about $70,000

and, upon motion, it was voted to adopt as the name of the organization 'The American Society of Agricultural Engineers'." The founders, not being aware of the previous use of the name "agricultural engineer" (at the Illinois Industrial University many years earlier), thought that they were responsible for the first use of the term.

Other accomplishments from the first meeting were the preparation and adoption of a constitution and by-laws, selection of the University of Illinois for the place of the 1908 meeting and the election of officers as follows:

President—J. B. Davidson
First Vice-President—C. A. Ocock
Second Vice-President—F. R. Crane
Secretary—L. W. Chase
Treasurer—W. M. Nye

Fred R. Crane had presided as temporary chairman of the first meeting. In view of the leadership shown by Davidson in promoting the idea and calling the meeting, it seems only natural that he should have been elected its first president.

Provision was made for Honorary Members, Members and Associate Members. Doubtless, the determination of qualifications for membership was a problem of considerable importance. Prestige could scarcely be attained without high standards. The group settled for: "Members of this Society shall be those who occupy or have occupied responsible positions in Agricultural Engineering work or instruction, together with such other persons as may be recommended by the Council."

Growth in membership was consistent from the beginning, though not always as rapid as desired by the founders. A sharp increase followed World War I.

It must have required, not only foresight, but courage for a group of youngsters, mostly in their middle twenties, to adopt a professional designation which enjoyed almost no acceptance at the time. Professional standing was almost non-existent. In 1955, Philip S. Rose (4), said: "Back in 1900, when I first went to North Dakota, if I had had the backing of a powerful society as we have today, we might have made much greater progress."

This "powerful society" was attained only after years of struggle on the part of many people. The nature and extent of this struggle may become more apparent from the words of Davidson (1): "With the expansion of agricultural education in the colleges, it was recognized by agricultural educators, particularly in those states where mechanical equipment, buildings and land reclamation were prominent, that engineering had a definite contribution to make to agriculture, but just how or by whom was not decided. In most institutions there was intense rivalry between the agricultural and engineering colleges, resulting in a lack of cooperation which made it difficult to care for any common activity. Engineering educators often wanted to supply the demand for instruction in the engineering of agriculture without disturbing the setup of the then existing professional branches. Agricultural educators wanted something special; they were not quite sure what, but nothing 'high brow'. Instruction had to be practical, and the instructors considered best were grease-it-and-fix-it men. Manufacturers were keen to cooperate in any project relating to sales, but were evasive and exclusive as far as engineering relationships were concerned.

"It was in such a situation of conflicting views that the young engineers attempting to develop the engineering related to agriculture found themselves. To be sure there were engineering and agricultural leaders who had a vision of the service engineering could contribute to agriculture, and were willing to grant that there might be a field for the professional agricultural engineer, but ideas had not crystallized and it was easier to criticize rather than to assist with the development of the new branch of the engineering profession. During this formative period, information for instruction was sorely lacking and teaching technique was wholly undeveloped."

Davidson's presidential address in 1908 showed vision and insight regarding problems facing the Society and forecast many of the later developments.

He first called attention to the necessity for developing technical literature beginning with the compilation of what was then available. He stated: "Nothing will aid so much in establishing our Society firmly in its proper field as the setting apart of the literature upon which the Society must be founded. Nothing else will be of such power in giving dignity and character to the work of the Agricultural Engineer." Would anyone today question the prestige which has been earned for our profession by our Society Journal, AGRICULTURAL ENGINEERING which was so ably developed and maintained by Raymond Olney?

Davidson then emphasized the importance of social contacts when he said: "The beneficial influence of having members of the profession meeting together and gaining enthusiasm and inspiration which is sure to be received by all in such a meeting cannot be overestimated."

He then stressed the importance of the development of a professional consciousness as essential to the attainment of prestige and eminent service to agriculture. This included universal acceptance of the selected designation of Agricultural Engineering.

He proposed the organization of professional divisions within the Society, even as we have today, with the opportunity of separate sessions in addition to the general meeting.

Stress was placed upon the necessity of cultivating closer relationships and cooperation among all agricultural engineers regardless of their business affiliation.

At the second meeting in 1908, R. P. Teele, of the U.S. Department of Agriculture, presented a paper entitled: "The Need of Agricultural Engineering Work by the National Government." In this paper he stated, in part: "In view of the facts stated, it seems much more logical to place all this engineering work in a separate bureau of agricultural engineering, with divisions of irrigation, drainage, buildings, machinery, and perhaps others. . . .

"In his correspondence with the Director of Experiment Stations regarding the presentation of a paper at this meeting by some representative of the Office of Experiment Stations, your secretary (L. W. Chase) suggested that he at least would like to know just how to go about securing a provision for some such work as has been outlined by the Department of Agriculture. It seems to me that this Association is the most fitting agency for beginning a movement for such work. It is the only organization representing the men engaged in the study of Agricultural Engineering. It is national in its scope and the men who compose it represent a large number of the institutions teaching agricultural science and in investigating agricultural problems. Presum-

ably, you have a greater appreciation than any other body of men of the needs of the agricultural industry of the United States along this line. . . .

"The creation of such a bureau as that suggested has been recommended by the Director of the O.E.S. and I believe by the Association of Colleges and Stations, but the recommendation has met with but little response."

Upon motion by L. W. Chase, the President appointed a committee of five to "investigate the subject of a Bureau of Agricultural Engineering and advise the Society."

Although success in this undertaking was not accomplished until in 1931, the efforts of the Society were continued and intensified from year to year until the Bureau was attained.

Davidson was concerned over the necessity for enlarging the Society and the responsibility of the individual in endeavoring to "secure a class of members whose addition will add to the standing and reputation of the Society". No society can long persist, let alone grow, without constantly increasing its membership. This was not easy as the technical development of the profession was not well advanced and no agricultural engineering curricula had yet been offered. In 1910, one year after the first professional curriculum was announced at the Iowa State College, a petition was received from 18 students "for permission to organize a Student Branch of the Society." That this movement had not been anticipated is evidenced by the action of the Society: "On motion the petition was granted, said student body to organize under such rules as the Society may designate." A photograph taken shortly after the December meeting when this action was taken, shows 32 members in the Student Branch group.

Beginning with this, our Society has maintained an active interest in the development of professional consciousness among students. Nebraska followed shortly after Iowa and, by 1919, Mississippi and Ohio had been added to the list. The total membership then was 46. Today there are 36 active Student Branches from Maine to California and from Washington to Florida with a membership of 1324. In addition, there are two active Branches in Canada and the third largest Branch in India. A total of 45 colleges and universities now offer professional curriculums in agricultural engineering, or their engineering equivalent. Twenty-five of these schools have curriculums that have been approved by the Engineers' Council for Professional Development (ECPD).

The first regional or section meeting appears to have been held in Auburn, Alabama in 1917. It was discontinued for a time and revived late in 1926. The Pacific Coast Section was organized in December 1924, the North Atlantic Section in April 1925, the Southwest Section late in 1925 and the North Central Section in May 1927. At present, there are 24 active geographical sections.

In December 1924, the Power and Machinery group held the first technical division meeting separate from the annual meeting. This action was followed in February 1926 by the Structures Division, in December 1928 by the Rural Electric Division and in 1929 by the Land Reclamation Division. There are now five technical divisions, namely: Power and Machinery, Soil and Water, Farm Structures, Rural Electric, and Education and Research.

From the beginning in 1907, papers presented at the meetings, together with official actions taken, were published in the "Transactions" of the Society. Although these were continued through 1929, they were gradually to give way to the monthly Journal, AGRICULTURAL ENGINEERING, which was started in September 1920. The first four numbers were published at Ames, Iowa. Beginning with January, 1921, the publication of the Journal was transferred to St. Joseph, Michigan, where, with the exception of two years, it has since been published.

For a considerable number of years, due to limited size of the Society and deep personal enthusiasm on the part of the members, it was possible to handle the responsibilities of the Secretary by members without pay. As the Society increased in membership, time came when the duties made demands greater than could be carried in this manner. Frank P. Hanson was appointed assistant secretary on salary, July 1, 1920, and was made Secretary on January 1, 1921, serving until November of that year when he resigned. The postwar business depression resulted in reduced revenues and temporary abandonment of the project. Hanson was succeeded by Raymond Olney who took the work on a part-time basis for nearly four years before being employed on a full-time basis. This change in status was made possible by increases in revenue from advertising in the Society's Journal. The marked financial success of the Society and its Journal, even during the depression years of the early 'thirties, was in no small measure due to the talent and devotion of its able secretary, Raymond Olney.

Any story of our Society would be incomplete without more personal tribute to the one man who initiated the idea, persisted in making it a reality and influenced its destinies for many years. What were Davidson's philosophies and ambitions for the Society? His stature as measured by his co-founders of the Society is thus expressed by Philip S. Rose (4): "Unlike so many of us, he knew, when he graduated, exactly what he wanted to do. He wanted to be a college professor and he wanted to establish this society. He was not a spellbinder as a public speaker, nor a tub-thumper on the platform, but a very earnest worker and a wonderful organizer. . . . It was Davidson's complete devotion to the ASAE that has bound me to your ranks during all these years. He is an unparalleled leader. . . . The architect of the future is your friend and mine, Professor J. B. Davidson. His dream of a great association has been fulfilled. The best I can hope for you is that you may be as lucky in your choice of leadership in the years ahead."

After many years of personal association with Davidson, your author believes that our Society is in great debt to him for his vision of great technical developments in the application of engineering techniques toward the solution of the problems of agriculture and to his strong conviction that our ability to serve agriculture effectively demands competence as engineers.

**References**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3 Olney, Raymond—The ASAE: 1906-1931. AGRICULTURAL ENGINEERING 12:185-6 (1931).

4 Rose, Philip S.—Address at the Pennsylvania State University, 1955 (unpublished).

5 Rose, Philip S.—Engineering's Service to Agriculture. AGRICULTURAL ENGINEERING 12:183 (1931).

6 Stout, O. V. P.—Agricultural Engineering Takes Its Place. AGRICULTURAL ENGINEERING 12:184-5 (1931).

# Presidents

J. Brownlee Davidson

Philip S. Rose

Charles A. Ocock

Howard W. Riley

Leon W. Chase

Wallace F. MacGregor

**J. Brownlee Davidson**—1st president, 1908. Head, agricultural engineering department, Iowa State College, Ames. **John G. Wynn**—2nd president, 1909. Engineer, Wayne Electric Works, Madison, Wis. (photo not available). **Philip S. Rose**—3rd president, 1910. Assistant editor, "The American Thresherman Gas Review," Clarke Publishing Co., Madison, Wis. **Charles A. Ocock**—4th president, 1911. Head, agricultural engineering dept., University of Wisconsin, Madison. **Howard W. Riley**—5th president, 1912. Head, farm mechanics dept., New York State College of Agriculture, Cornell University, Ithaca. **Leon W. Chase**—6th president, 1913. Head, agricultural engineering dept., University of Nebraska, Lincoln. **Wallace F. MacGregor**—7th president, 1914. Mechanical engineer, J. I. Case Company.

Harry H. Musselman

Frank M. White

Daniels Scoates

Raymond Olney

Frank N. G. Kranick

Earl A. White

**Harry H. Musselman**—8th president, 1915. Head, farm mechanics dept., Michigan State College, East Lansing. **Frank M. White**—9th president, 1916. Professor of agricultural engineering, University of Wisconsin, Madison. **Edmund B. McCormick**—10th president, 1917. Agricultural engineer, USDA, Office of Public Roads and Rural Engineering (photo not available). **Daniels Scoates**—11th president, 1918. Head, agricultural engineering dept., Mississippi A & M College, State College. **Raymond Olney**—12th president, 1919. Editor of "Power Farming," St. Joseph, Michigan. **Frank N. G. Kranick**—13th president, 1920. Manager, tractor bearings division, Hyatt Roller Bearing Co., Chicago, Ill. Earl A. White—14th president, 1921. Technical editor of "Farm Implement News," Chicago, Ill.

Arthur J. R. Curtis

Emil W. Lehmann

Samuel H. McCrory

Frederick W. Ives

Frederick A. Wirt

Oscar W. Sjogren

**Arthur J. R. Curtis**—15th president, 1922. Manager, cement products bureau, Portland Cement Association. **Emil W. Lehmann**—16th president, 1923. Professor and head, department of farm mechanics, University of Illinois, Urbana. **Samuel H. McCrory**—17th president, 1923-24. Chief, division of agricultural engineering, Bureau of Public Roads, USDA. **Frederick W. Ives**—18th president, 1924-25. Professor and head, agricultural engineering dept., Ohio State University, Columbus. **Frederick A. Wirt**—19th president, 1925-26. Advertising manager, J. I. Case Company. **Oscar W. Sjogren**—20th president, 1926-27. Chairman, agricultural engineering dept., University of Nebraska, Lincoln.

Oliver B. Zimmerman

William Boss

William G. Kaiser

Robert W. Trullinger

Leonard J. Fletcher

Charles E. Seitz

**Oliver B. Zimmerman**—21st president, 1927-28. Assistant to manager, engineering department, International Harvester Company. **William Boss**—22nd president, 1928-29. Professor and chief, agricultural engineering division, University of Minnesota, Minneapolis. **William G. Kaiser**—23rd president, 1929-30. Agricultural engineer and assistant manager, cement products bureau, Portland Cement Association. **Robert W. Trullinger**—24th president, 1930-31. Assistant in experiment station administration, Office of Experiment Stations, USDA. **Leonard J. Fletcher**—25th president, 1931-32. General supervisor of agricultural sales, Caterpillar Tractor Company. **Charles E. Seitz**—26th president, 1932-33. Professor and head, agricultural engineering dept., Virginia Polytechnic Institute, Blacksburg.

# of ASAE

Arthur Huntington

Glen W. McCuen

Lawrence F. Livingston

Ralph U. Blasingame

Arnold P. Yerkes

Samuel P. Lyle

**Arthur Huntington**—27th president, 1933-34. Public relations engineer, Iowa Electric Light and Power Co. **Glen W. McCuen**—28th president, 1934-35. Head, agricultural engineering dept., Ohio State University, Columbus. **Lawrence F. Livingston**—29th president, 1935-36. Manager, agricultural extension section, E. I. du Pont de Nemours & Co. **Ralph U. Blasingame**—30th president, 1936-37. Professor and head, agricultural engineering dept., Pennsylvania State College. **Arnold P. Yerkes**—31st president, 1937-38. Editor, "Tractor Farming," International Harvester Co. **Samuel P. Lyle**—32nd president, 1938-39. Principal agricultural engineer, in charge of agricultural and home economics section, Extension Service, U.S. Dept. of Agriculture.

Karl J. T. Ekblaw

Elmer E. Brackett

George W. Kable

Harry B. Walker

Arthur W. Turner

Rudolph H. Driftmier

**Karl J. T. Ekblaw**—33rd president, 1939-40. Agricultural engineer, American Zinc Institute, and vice-president, Western Advertising Agency. **Elmer E. Brackett**—34th president, 1940-41. Professor and chairman, agricultural engineering dept., University of Nebraska, Lincoln. **George W. Kable**—35th president, 1941-42. Editor, "Electricity on the Farm," New York, N. Y. **Harry B. Walker**—36th president, 1942-43. Chairman, agricultural engineering dept., University of California. **Arthur W. Turner**—37th president, 1943-44. Educational advisor, International Harvester Company. **Rudolph H. Driftmier**—38th president, 1944-45. Head, agricultural engineering dept. and plant operations dept., University of Georgia, and supervising engineer, the University System of Georgia.

J. Dewey Long

Mark L. Nichols

George A. Rietz

Arthur J. Schwantes

Frank J. Zink

Fred C. Fenton

**J. Dewey Long**—39th president, 1945-46. Director of education and market research, Douglas Fir Plywood Association. **Mark L. Nichols**—40th president, 1946-47. Chief of research, Soil Conservation Service, U.S. Department of Agriculture. **George A. Rietz**—41st president, 1947-48. Manager, farm industry division, General Electric Company. **Arthur J. Schwantes**—42nd president, 1948-49. Professor and chief, division of agricultural engineering, University of Minnesota, Minneapolis. **Frank J. Zink**—43rd president, 1949-50. Consulting agricultural engineer and president, Frank J. Zink Associates, Chicago, Ill. **Fred C. Fenton**—44th president, 1950-51. Head, agricultural engineering dept., Kansas State College, Manhattan.

Stanley M. Madill

Ivan D. Wood

Edwin W. Tanquary

George B. Nutt

Wayne H. Worthington

Roy Bainer

**Stanley M. Madill**—45th president, 1951-52. Executive engineer, John Deere Waterloo Tractor Works of Deere Manufacturing Co., Waterloo, Iowa. **Ivan D. Wood**—46th president, 1952-53. Irrigation engineer, SCS, U.S. Department of Agriculture, Denver, Colo. **Edwin W. Tanquary**—47th president, 1953-54. Staff engineer, farm implement division, International Harvester Company. **George B. Nutt**—48th president, 1954-55. Head, agricultural engineering dept., Clemson Agricultural College, Clemson, S. C. **Wayne H. Worthington**—49th president, 1955-56. Director of engineering research, John Deere Waterloo Tractor Works, Waterloo, Iowa. **Roy Bainer**—50th president, 1956-57. Chairman, agricultural engineering dept. and assistant dean of engineering, University of California, Davis.

# ASAE Professional Divisions and Division Chairmen

## Power and Machinery Division

**(Division organized 1922)**

1922 —J. B. Davidson
1923 —J. B. Davidson
1923-24—F. A. Wirt
1924-25—F. A. Wirt
1925-26—A. P. Yerkes
1926-27—G. W. Iverson
1927-28—E. R. Wiggins
1928-29—L. J. Fletcher
1929-30—R. U. Blasingame
1930-31—H. E. McCray*
1931-32—G. W. McCuen
1932-33—W. L. Zink
1933-34—R. B. Gray
1934-35—A. W. Lavers
1935-36—F. J. Zink
1936-37—O. E. Eggen
1937-38—F. W. Duffee
1938-39—F. P. Hanson
1939-40—E. M. Mervine
1940-41—A. W. Turner
1941-42—A. J. Schwantes
1942-43—D. A. Milligan
1943-44—R. I. Shawl
1944-45—B. G. Van Zee
1945-46—B. G. Van Zee
1946-47—A. W. Clyde
1947-48—C. L. Zink
1948-49—D. C. Heitshu
1949-50—E. L. Barger
1950-51—E. W. Tanquary
1951-52—Geo. B. Hill
1952-53—R. L. Worrell
1953-54—Geo. M. Eveleth
1954-55—Roy Bainer
1955-56—B. T. Virtue
1956-57—L. G. Kopp

*Vacancy filled by O. B. Zimmerman

## Soil and Water Division

**(Division organized 1921)**

1921 —D. P. Weeks
1922 —D. P. Weeks
1923 —S. H. McCrory
1923-24—John Swenehart
1924-25—John Swenehart
1925-26—O. V. P. Stout
1926-27—H. B. Roe
1927-28—G. S. Knapp
1928-29—Q. C. Ayres
1929-30—I. D. Wood
1930-31—L. F. Livingston
1931-32—W. W. McLaughlin
1932-33—J. A. King
1933-34—W. W. Weir
1934-35—L. A. Jones
1935-36—Virgil Overholt
1936-37—C. E. Ramser
1937-38—T. B. Chambers
1938-39—M. R. Lewis
1939-40—Ray W. Carpenter
1940-41—I. D. Mayer
1941-42—H. S. Riesbol
1942-43—W. E. Meek
1943-44—G. E. Martin
1944-46—Howard Matson
1946-47—I. D. Wood
1947-48—R. C. Hay
1948-49—Aldert Molenaar
1949-50—R. B. Hickok
1950-51—J. L. McKitrick
1951-52—R. R. Poynor
1952-53—G. E. Ryerson
1953-54—A. J. Wojta
1954-55—T. W. Edminster
1955-56—W. J. Liddell
1956-57—J. G. Sutton

## Farm Structures Division

**(Division organized 1922)**

1922 —W. G. Kaiser
1923 —W. G. Kaiser
1923-24—F. W. Ives
1924-25—W. A. Foster
1925-26—D. G. Carter
1926-27—D. G. Carter
1927-28—W. G. Kaiser
1928-29—John Swenehart
1929-30—J. L. Strahan
1930-31—F. C. Fenton
1931-32—W. C. Harrington
1932-33—Henry Giese
1933-34—C. F. Miller
1934-35—W. G. Ward
1935-36—K. J. T. Ekblaw
1936-37—A. M. Goodman
1937-38—R. G. Ferris
1938-39—J. D. Long
1939-40—E. D. Anderson
1940-41—Wallace Ashby
1941-42—G. B. Hanson
1942-43—S. A. Witzel
1943-44—Ray Crow
1944-45—D. G. Carter
1945-46—D. G. Carter
1946-47—R. A. Glaze
1947-48—J. C. Wooley*
1948-49—J. F. Schaffhausen
1949-50—W. V. Hukill
1950-51—T. E. Long
1951-52—C. K. Otis
1952-53—D. B. Poor
1953-54—N. H. Curry
1954-55—C. H. Jefferson
1955-56—C. F. Kelly
1956-57—F. J. Reynolds

*Vacancy filled by Henry Giese

## Electric Power and Processing Division

**(formerly Rural Electric)**
**(Division organized 1925)**

1925-26—Arthur Huntington
1926-27—Arthur Huntington
1927-28—E. A. White
1928-29—E. A. Stewart
1929-30—E. E. Brackett
1930-31—J. E. Waggoner*
1931-32—G. W. Kable
1932-33—T. E. Hienton
1933-34—Richard Boonstra
1934-35—E. C. Easter
1935-36—I. P. Blauser
1936-37—G. A. Rietz
1937-38—F. E. Price
1938-39—B. P. Hess
1939-40—R. R. Parks
1940-41—J. P. Schaenzer
1941-42—A. V. Krewatch
1942-43—M. H. Lloyd
1943-44—P. T. Montfort
1944-45—W. D. Hemker
1945-46—W. D. Hemker
1946-47—C. J. Hurd
1947-48—J. B. Stere
1948-49—B. D. Moses
1949-50—C. P. Wagner
1950-51—D. E. Wiant
1951-52—H. S. Hinrichs
1952-53—A. H. Hemker
1953-54—E. T. Swink
1954-55—W. J. Ridout, Jr.
1955-56—H. S. Pringle
1956-57—R. R. Mauney

*Vacancy filled by E. C. Easter

## Education and Research Division

**(formerly College)**
**(Division organized 1921)**

1921 —F. W. Ives
1922 —Daniels Scoates
1923 —Daniels Scoates
1923-24—Daniels Scoates
1924-25—Daniels Scoates
1925-26—William Boss
1926-27—L. J. Fletcher
1927-28—H. B. Walker
1928-29—J. B. Davidson
1929-30—E. R. Jones
1930-31—S. P. Lyle
1931-32—C. E. Seitz
1932-33—D. G. Carter
1933-34—G. W. McCuen
1934-35—J. C. Wooley
1935-36—R. H. Driftmier
1936-37—Hobart Beresford
1937-38—E. G. McKibben
1938-39—B. B. Robb
1939-40—F. W. Duffee
1940-41—D. S. Weaver
1941-42—H. E. Pinches
1942-43—Clyde Walker
1943-44—R. C. Miller
1944-45—Geo. B. Nutt
1945-46—Geo. B. Nutt
1946-47—H. J. Barre
1947-48—A. J. Schwantes
1948-49—A. W. Farrall
1949-50—Roy Bainer
1950-51—O. C. French
1951-52—E. W. Schroeder
1952-53—F. R. Jones
1953-54—L. W. Hurlbut
1954-55—F. W. Peikert
1955-56—F. A. Kummer
1956-57—C. G. E. Downing

## Honorary Members of ASAE

*Arthur O. Fox (1908)†
*Franklin H. King (1908)
*Bascom B. Clarke (1911)
*John B. Bartholomew (1921)
*Joseph O. Oliver (1921)
*William Louden (1921)
*Willard A. Van Brunt (1922)
*Elwood Mead (1923)
*Samuel Fortier (1923)
*Oscar Van Pelt Stout (1928)
*John J. Glessner (1929)
*William N. Rumely (1933)
*Oliver B. Zimmerman (1937)
Claude R. Wickard (1945)
Walter W. McLaughlin (1946)
*J. Brownlee Davidson (1946)
G. E. P. Smith (1955)
Leonard J. Fletcher (1956)
Harry B. Walker (1957)
Dwight D. Eisenhower (1957)
Ezra T. Benson (1957)

*Deceased
†Year elected

## Dates and Places of ASAE Annual Meetings

December, 1907—Madison, Wis. (Organization meeting)
December, 1908—Champaign, Ill. (First annual meeting)
December, 1909—Ames, Iowa
December, 1910—Lafayette, Ind.
December, 1911—St. Paul, Minn.
December, 1912—Chicago, Ill.
December, 1913—Chicago, Ill.
December, 1914—Chicago, Ill.
December, 1915—Chicago, Ill.
December, 1916—Chicago, Ill.
December, 1917—Chicago, Ill.
December, 1918—Chicago, Ill.
December, 1919—Chicago, Ill.
December, 1920—Chicago, Ill.
December, 1921—Chicago, Ill.
December, 1922—St. Louis, Mo.
November, 1923—Chicago, Ill.
June, 1924—Lincoln, Neb.
June, 1925—Madison, Wis.
June, 1926—Lake Tahoe, Calif.
June, 1927—St. Paul, Minn.
June, 1928—Washington, D.C.
June, 1929—Dallas, Tex.
June, 1930—Moline, Ill.
June, 1931—Ames, Iowa
June, 1932—Columbus, Ohio
June, 1933—Lafayette, Ind.
June, 1934—Detroit, Mich.
June, 1935—Athens, Ga.
June, 1936—Estes Park, Colo.
June, 1937—Urbana, Ill.
June, 1938—Pacific Grove, Calif.
June, 1939—St. Paul, Minn.
June, 1940—State College, Pa.
June, 1941—Knoxville, Tenn.
June, 1942—Milwaukee, Wis.
June, 1943—Lafayette, Ind.
June, 1944—Milwaukee, Wis.
June, 1945—Chicago, Ill. (Annual dinner only)
June, 1946—St. Louis, Mo.
June, 1947—Philadelphia, Pa.
June, 1948—Portland, Ore.
June, 1949—East Lansing, Mich.
June, 1950—Washington, D.C.
June, 1951—Houston, Tex.
June, 1952—Kansas City, Mo.
June, 1953—Pittsburgh, Pa.
June, 1954—Minneapolis, Minn.
June, 1955—Urbana, Ill.
June, 1956—Roanoke, Va.
June, 1957—East Lansing, Mich.

## . . . The Engineer's Place in Agriculture

*(Continued from page 377)*

ical harvest, higher bolls on cotton plants, a self-defoliating cotton that will reduce leaf trash at harvest time, etc.

The viticulturists have already demonstrated the feasibility of retrellising the vineyard to position grapes of the wine and raisin types for mechanical harvest. A prototype harvester developed for grapes looks quite promising.

The pomologists have shown an intense interest in the mechanical harvesting of such tree crops as walnuts, almonds, prunes, olives, peaches, and pears for processing. The first four of these crops are quite well adapted to mechanical harvest. The latter two can be taken off the tree mechanically but are bruised somewhat as they fall through the branches. Here, then, the food technologist enters the picture with chemical sprays or dips that will retard surface deterioration long enough to get the fruit into a can. Preliminary trials with pears for the cannery were encouraging enough to justify continuing the studies.

Changes in cultural practices and in timing the cutting of green asparagus are the vegetable crop specialist's contributions to a possible mechanization of this important crop. An experimental mechanical harvester is undergoing field tests this season in competition with hand cutting. If cutting can be timed with growth to give 4 or 5-day intervals between harvest operations without sacrificing too much yield, one machine could handle 80 acres of asparagus during a season's run.

The reduction of chore labor in connection with livestock feeding and poultry production offers one of the best opportunities for further improving the labor-production ratio. Devising improvements in existing structures or developing new ones, coupled with automatic or semiautomatic operations to reduce labor requirements, offers a real challenge to the engineer. With proper equipment and facilities, one man can handle 1,000 beef animals on full feed, or milk 60 cows by machine twice a day. Studies in southern California indicate that 60 percent of the poultryman's time is spent handling eggs. The development of automatic egg-recording, collecting, cleaning, and grading equipment is the logical starting point for an engineer interested in this problem.

The use of electronics in agriculture has a great potential. With the wide-spread adoption of electricity throughout rural America has come a need for automatic controls of many types. Color sorting and sizing of fruits, vegetables, eggs, and seeds can be done accurately and rapidly by electronic units. The detection and rejection of tramp iron in livestock feeds is another good example of the application of electronics to agriculture. The analog computer receives the many variables peculiar to agricultural production and within seconds arrives at an answer that would otherwise take hours to reach. Several experiment stations have already applied the electronic "brain" to the study of milk production.

Engineers working in the field of soil and water have one of the greatest challenges of all — that of protecting the nation's soils from erosion and maintaining them in condition for maximum production. Supplemental irrigation and adequate drainage will become increasingly important in the economy of the country. There is much to be learned about the causes of and remedies for soil compaction. Here again the solution will depend upon cooperative effort between the soil and plant scientists and the agricultural engineer.

Finally, the agricultural engineer must give full consideration to quality — quality as applied to machine performance. With few exceptions, the substitution of machine for hand operations has resulted in a reduction of the quality or yield of the crop involved. In most instances, such losses are justified under the present economic situation; however, economic situations could change. It behooves us all, therefore, to strive for the utmost in quality performance.

# Fifty Years of Tractor Development in the U.S.A.

**Roy B. Gray and E. M. Dieffenbach**
Fellow ASAE Member ASAE

BECAUSE of the impact of agricultural engineering on agricultural tractor development, which has made mechanization of American agriculture possible, and because of the close tie-up, through the American Society of Agricultural Engineers, with agricultural engineers in related endeavors, it is only appropriate that the half century progress in easing the farmer's burden be reviewed at this time.

Tractor development and production by American manufacturers for the past 50 years provides the key to the low labor requirement of the United States farmer in producing his annual abundance of food, feed, and fiber. About 1900 it took 147 man-hours to produce 100 bu of corn, 283 man-hours to produce 500 lb of cotton, and 108 man-hours to produce 100 bu of wheat. The average figures for the 1950-54 period indicate that it required 34 man-hours to produce 100 bu of corn, 118 man-hours to produce 500 lb of cotton, and 25 man-hours to produce 100 bu of wheat where these crops were more or less mechanized. At the turn of the century one man produced only enough for 6 persons; now he can produce enough agricultural products for 20 persons. This improvement in labor requirements, caused largely by mechanization, which in turn depends mainly on tractor power, is in great measure responsible for the high standard of living that is enjoyed by the American farmer today.

## Before 1900

Before 1900 the main source of power was the heavy portable steam engine and the steam traction engine, both used mainly for threshing; though the steam traction engine was used to some extent for plowing. A threshing crew included 2 or 3 men to operate the steam engine, a couple of men to haul coal and water, 2 or 3 men to operate the thresher, a water boy, stackers, plus several men to haul bundles to the thresher and the grain away. These hauling jobs had to be done with horses and wagons.

The early attempts at gasoline tractor development, sparked by the need for reducing the size of the threshing crews, consisted mainly of mounting a stationary gasoline engine on a chassis patterned naturally after the steam traction engine chassis. This combination became the self-propelled gas engine. Experimenters even built a gasoline tractor that looked like a steam traction engine to minimize, they figured, the frightening of horses. In some instances, to carry this idea further, a whistle was provided.

However, before a tractor could be fully envisioned, a promising gasoline or internal-combustion engine was necessary. For this engine to become acceptable, an adequate supply of petroleum fuel had to be assured.

As for the internal-combustion engine, about the first on record was the one credited to Abbi Hautefeuille, a French physicist, who in 1678 conceived the idea of burning a small amount of gunpowder in a chamber. While he continued experimenting, other Frenchmen, Dutch, English, and Americans developed many and various ideas for producing power. Finally Otto, a German, devised a practical power unit of the internal-combustion type. This was a one-cylinder affair that made use of four piston strokes per explosion, as we know it today on four-cycle engines—known also as the "Otto cycle." This development did not begin to assume importance until 1876, when it had reached a reasonably satisfactory stage. The patents of the Otto cycle engine, however, were so basic in character that it was not until they expired in 1890 that other companies started to work on similar engines. By 1899, 100 firms in the United States were making internal-combustion engines.

Another early development of this nature which was to play an important role in tractor development was that of the compression-ignition engine. This was the handiwork of Rudolph Diesel, a German scientist, who patented his first engine in 1892. Coal dust, a useless by-product in mining areas, was blown into the cylinder with compressed air. Coal dust, however, was not feasible as a fuel. But it was not long before Diesel came out with an oil-burning, compression-ignition engine that proved successful, and the idea spread.

In the early internal-combustion engine experimenters used gunpowder, turpentine, and gas—natural or artificial—for fuel, but it was actually the discovery of petroleum fuel in quantity that speeded gasoline engine development. In

Paper prepared expressly for the Golden Anniversary issue of AGRICULTURAL ENGINEERING.

The authors—ROY B. GRAY and E. M. DIEFFENBACH—respectively, was formerly head, Farm Machinery Section, AERD, USDA, now retired and serving as collaborator with USDA; and is agricultural engineer, Farm Machinery Section, AERD, USDA.

## Before 1900

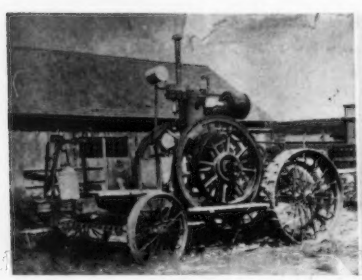

Fig. 1 Froelich (1892)

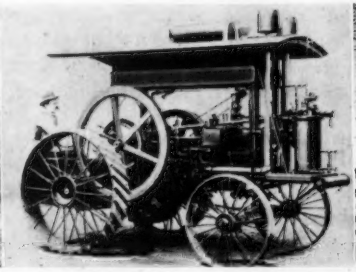

Fig. 2 Patterson (1892)

Fig. 3 Morton (1899)

Fig. 4 Hart Parr No. 1 (1902)

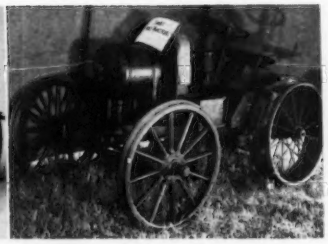

Fig. 5 Ford (1907)

1859, at Titusville, Pa., E. L. Drake drilled his first oil well, bringing forth the petroleum product that paved the way for the creation of a great industry. With petroleum fuel available, the internal-combustion engine made rapid strides. Who first made use of petroleum fuel in such an engine it is difficult to state definitely.

Probably the first gasoline tractor, however, that was an operating success was the Froelich (Fig. 1), built in 1892 by the Waterloo Tractor Engine Co., the forerunner of the John Deere line of tractors. This machine was powered by a 20-hp engine, with hit-and-miss governor and make-and-break electric ignition. Another tractor of this period was the Patterson (Fig. 2), 1892, but it was shelved after several years of experimentation because of carburetion and ignition difficulties. The Patterson was the first tractor that used the internal-combustion engine, in which the J. I. Case Co. was interested. The Case Co. had for years been producing an enviable line of steam traction engines. Other early gasoline tractors were the Hockett (Sterling), 1893; the Van Duzen, the Otto, and the Lambert, all in 1894; the Huber, 1898; and the Morton (Fig. 3) in 1899. The Morton turned out to be the forerunner of the International Harvester Company's line of tractors.

### 1900 to 1910

In 1902 C. W. Hart and C. H. Parr built their first tractor model, (Fig. 4) a year later their second model considerably improved, in 1907 their 30-60 "Old Reliable," and in 1909 the Hart-Parr 15-30, a tricycle type. Hart and Parr formed a company that was to become a part of The Oliver Corp., and they are credited with having founded the gasoline tractor industry.

Other tractors of this period were the Electric Wheel, 1904; the Dissinger, 1904; the Eason-Wysong Auto-Tractor, 1905; and the Ohio, 1905. The Ohio Co. had bought the patent rights from Morton and had built a few tractors for the International Harvester Co. in 1905. A couple years later the latter company built its first tractor (Fig. 6), which, like the Ohio tractor, was friction drive, effected by friction pulleys for both forward and reverse. Other models were the Waterous in 1906, the Transit and the Ford each in 1907, the Russell, Olds, Joy-McVicker, and the Geiser in 1909.

In 1909 the Avery Co., Peoria, Ill., entered the tractor field with a tractor-truck. This was a utility machine powerful enough for traction work, capable of hauling on roads, and suitable for stationary power. This company was a steam tractor builder in a large way. The Ford tractor of 1907 was an experimental one (Fig. 5), using parts of a Ford car (front wheels and axle and steering) and the rear wheels were binder bullwheels.

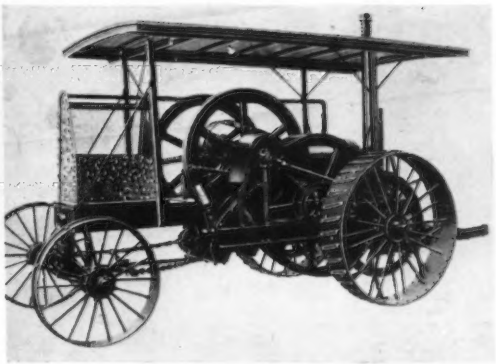

Fig. 6 International Harvester (1906)

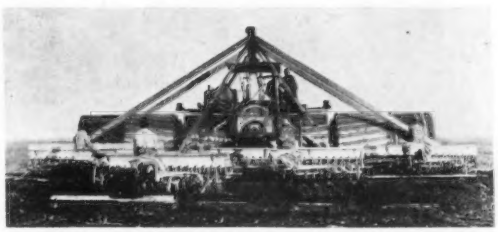

Fig. 7 Holt Steam Traction Engine (1903)

Also in 1907 Benjamin Holt produced one of the earliest gasoline-engine-powered track-type tractors. This had a front tiller or steering wheel. He had already made experimental track-laying steam-engine-driven models in 1904 and 1906. Experiments by various agencies had already been under way in an attempt to develop devices to improve traction and reduce ground-pressure intensity, by tracks or other schemes. For instance, the Minnis tractor of 1867, powered by a steam engine, was fitted with a track in front for steering and two track-type drivers in the rear; the Parvins steam plow of 1873 with a track-type driver in the rear; the Strattons steam traction engine of 1893, driven by two tracks—two front steering wheels; the Lombard steam log hauler, with sled runners in front for steering, of 1907, and the Bullock creeping grip (gasoline) of 1910 with two tracks. Attempts had even been made to use wide, large-diameter wheels like the outfit built in 1900 by the Best Mfg. Co.; the wheels were two wood-covered drivers each 9 ft in diameter and 15 ft wide. The Holt steam traction engine (Fig. 7) built about 1903 had 6-ft sectional wheels 7½ ft in diameter and totaling a width of 18 ft on each side.

Although tractors powered with internal-combustion engines had been manufactured in a limited way for some 20 years, it was not until the first Winnipeg (Canada) trial in 1908 (under the auspices of the Winnipeg Industrial Exhibition) that the public had opportunity to compare field performances of both steam and gasoline tractors. In this and succeeding trials held in 1909, 1910, 1911, and 1912, representatives of many countries witnessed the competition

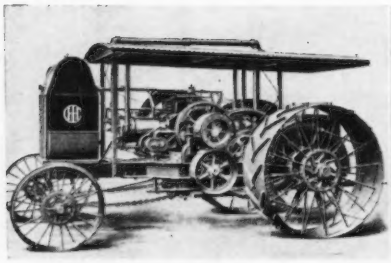

Fig. 8 Mogul (1910)

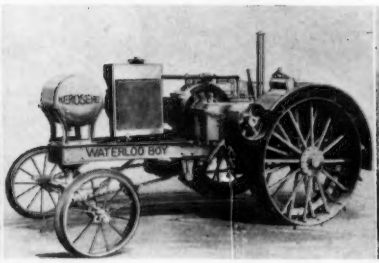


Fig. 9 Waterloo Boy (1916)

Fig. 10 Wallis Cub (1913)

Fig. 11 Hart Parr "Little Devil" (1915)

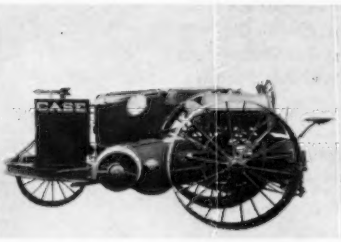


Fig. 12 Case 10/20 (1915)

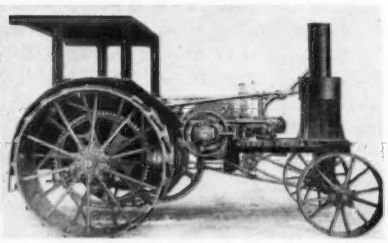

Fig. 13 Avery (1913)

of gasoline tractors plowing in the same fields with steam tractors. The contests showed, even at this early stage, that the gasoline tractor had great possibilities.

A sidelight on these trials was the keen rivalry of the participants and the steps the contestants took to best the other fellow. It came to such a pitch that an operator could hardly tell what to expect in his tractor the next morning when the trials were scheduled to start. Soap might have been put in his engine hopper or open cooling system, and the water, upon warming up, would suddenly foam up and boil out. He might find his ignition out of time, his carburetor missing, or water in his fuel tank. It meant all day and night vigilance. At least, the interest created by the trials encouraged experimenters and manufacturers sufficiently for them to continue their efforts. These were the pioneers of the tractor industry.

With few exceptions, the gasoline tractors manufactured up to 1910, and in many cases for years later, were fitted with automatic intake valves, hit-and-miss governors, and make-and-break ignition systems. As a rule, electric current for ignition was supplied by dry batteries for starting, and a low-voltage, direct-current magneto or generator (auto sparker) for furnishing current thereafter. In some cases a low-voltage oscillating magneto furnished the spark required for starting and running. The frames of the wheel tractors were built up of channel iron, real bridge construction, to which engine and other parts were bolted. Most large drive gears were of cast iron, exposed to the dust and dirt, that wore rapidly. The built-up drivewheels, frequently 6 ft and sometimes 8 ft in diameter, turned on a one-piece "dead" or floating axle. Selective type of transmission, where there were any gears to select (many had only one speed forward) was common, although friction drive and planetary-gear transmissions were not uncommon. A wide variety of clutches was provided.

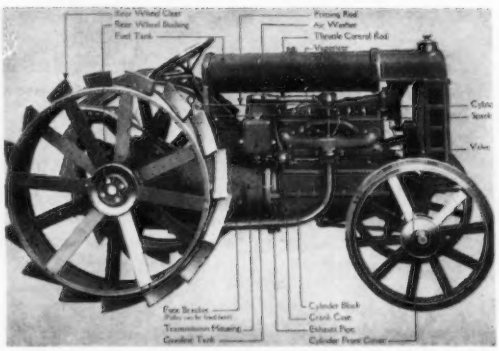

Fig. 14 Fordson (1917)

## 1910 to 1920

There was rather bitter competition during this period between the steam and gasoline tractor manufacturers. In one instance, the president of a gasoline tractor company stated that, when he first went into business, the steam tractor manufacturers refused to load their machines on the same freight cars with gasoline tractors.

During this decade tractor manufacturing companies were increasing in number (from 15 to over 160), and existing companies began presenting more than one model.

The International Harvester Co. came out in 1910 with its 45-hp Mogul (Fig. 8) which had a two-cylinder horizontal opposed engine, with gear drive forward and friction reverse; in 1911 the 45-hp Titan with a two-cylinder horizontal cylinder engine, with gear drive forward and reverse; in 1912 with the 15-30 single-cylinder Mogul; in 1914 with the 10-20 Titan with a twin horizontal cylinder engine, and the 8-16 Mogul with a one-cylinder engine and planetary-gear drive forward and reverse; in 1915 with the 15-30 Titan with four-cylinder horizontal engine, and in 1918

## 1910 to 1919

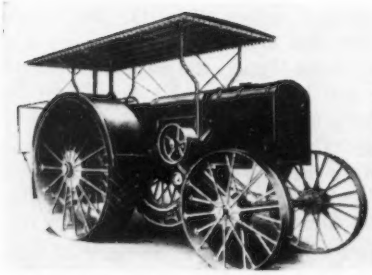

Fig. 15 Huber 30/60 (1914)

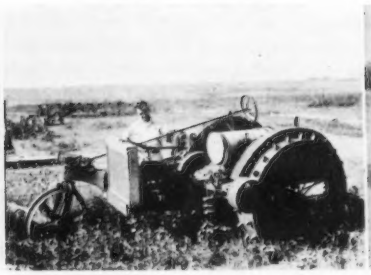

Fig. 16 Allis-Chalmers 3-wheeler (1914)

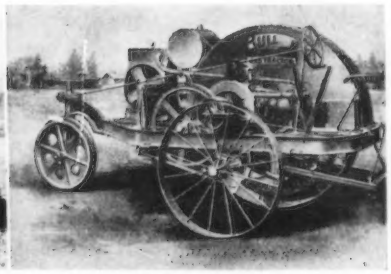

Fig. 17 Bull (1913)

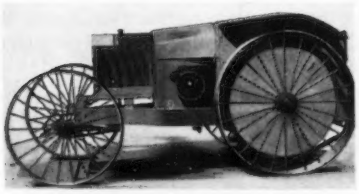

Fig. 18 Parrett (1916)

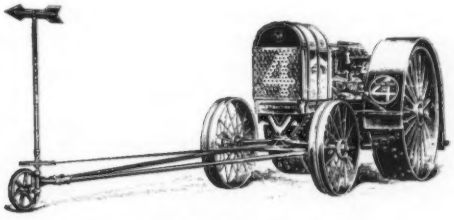

Fig. 19 Big Four 30 (1910)

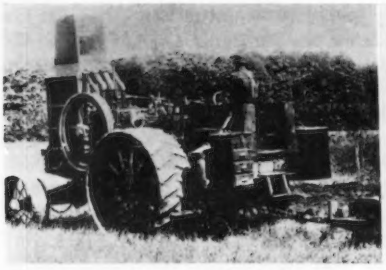

Fig. 20 Rumely "Kerosene Annie" (1910)

Fig. 21 Twin City 40 (1911)

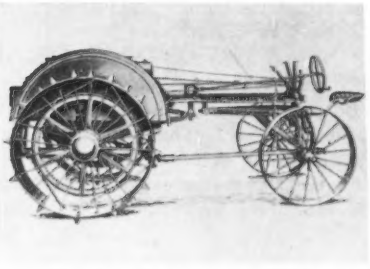

Fig. 22 Moline Universal (1914)

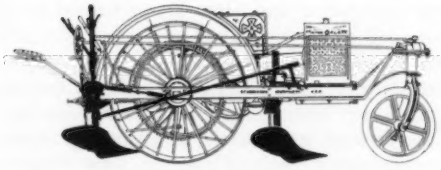

Fig.23 Louisville Motor Plow (1914)

Fig. 24 Holt (1912)

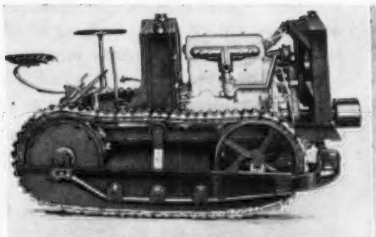

Fig. 25 Cleveland H (1918)

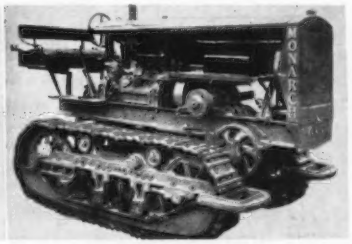


Fig. 26 Monarch (1918)

with the 8-16 International, the first to bear the company's name and one of its early attempts to design a machine suitable for the smaller farms.

This same year (1918) the company came out with a practical power take-off for its tractors. This permitted direct transmission power from the engine to such equipment as mowers, small combines, and sprayers. It was such an important development that most tractor manufacturers soon had their tractors so equipped and started to fit many of their field machines for power take-off drive.

With the appearance of the Waterloo Boy (Fig. 9) in 1916 with its twin horizontal kerosene-burning engine and 180-deg crankshaft, Deere and Co. inaugurated a basic engine design to be found in most of its current models. This machine made an excellent performance record at the National Tractor Demonstration in 1918.

The manufacture of the Bear tractor by the Wallis Tractor Co. in 1912 proved to be the advance guard of the Massey-Harris line of tractors. This machine had one front steering wheel with a directional vane that moved with it, and two rear drivers. In 1913 the Wallis Cub (Fig. 10) appeared, also a three-wheeler but of a more compact design involving a revolutionary development—a frameless-type construction. In this the one piece U-shaped boiler-plate steel crank-case and transmission housing provided the backbone of the machine. This type of construction created much interest in the industry, and soon designs by various manufacturers were introduced.

Then in 1917 the Ford Motor Co., after considerable experimentation, started production of the Fordson (Fig. 14), also of unit-frame construction but of cast iron instead of boiler-plate steel. The tractor was light for its power and relatively low in price. This frame-type construction was so practicable that most tractor manufacturers soon adopted the idea in the construction of their own products.

This Fordson development came at a most opportune time—the first year that the United States became involved in World War I. Horses were being shipped abroad by boat loads, labor was becoming increasingly scarce, materials were becoming more restricted, and something was needed to bridge the gap. As the manufacture of the Fordson was set up on a production basis—over 34,000 were produced in 1918 and 100,000 by 1925, 25 and 75 percent, respectively, of the tractors produced by all companies — the difficulties caused by the war were overcome to a large extent. After 1925, with the return to more normal conditions, Fordson production decreased, and in 1928 its manufacture in the United States was discontinued.

Tractor sizes were approaching a peak in this decade, many already at the 40 to 65-hp level, and the Hart-Parr Co. produced one of about 100 hp. This size proved impracticable, and its production was soon abandoned. However, the company built several other models, including the three-wheeled (one front wheel) Hart-Parr 40 in 1912, with its vertical two-cylinder engine; the Hart-Parr "Little Devil" (Fig. 11) in 1915 (also a three-wheel machine but with two front steering wheels and one rear driver) and the Hart-Parr 15-30 in 1918, following more or less the conventional styling of the period.

In 1911 the J. I. Case Co. resumed tractor building with the Case 30-60 (the company had built its first machine in 1892), and the year following it produced the Case 20-40. This latter tractor performed exceedingly well at the Winnipeg Trials this same year. In 1915 Case built its first tractor with a 4-cylinder vertical engine (Fig. 12). This was a three-wheeled machine with a single front steering wheel, the right rear a driver, and the left rear an idler. By 1918 the company produced the 9-18 model and in 1919 the 15-27, both of one-piece frame or so-called unit construction.

In 1912 the Avery Co. of Peoria started production on the Avery 12-25, about the first of its line of tractors that made use of a sliding-frame gear shift to effect changes in tractor speed. Fig. 13 shows the 1913 Avery 40-80.

The Huber Co. began building tractors again in 1914 with the 30-60 Huber (Fig. 15). (The first tractor built by this company was in 1898.)

In 1914 the Allis-Chalmers Co. built its first tractor, the three-wheeled 10-18-hp (Fig. 16), and in 1916 it came out with a 6-12-hp cultivating tractor also capable of pulling a plow. This company soon became a large contender in the agricultural tractor field.

Many other tractor companies also appeared in this period, and many of them for one reason or another discontinued making tractors or were absorbed by other companies. Among the companies that discontinued production were the Thompson Breese, and the Bates Tractor Co. of Lansing, Mich. Also the Russell, Gaar-Scott, Nichols and Sheppard, Buffalo-Pitts, and Altman Taylor companies, which had manufactured very successful steam traction engines in the early days. In addition, the Lambert Gas and Gasoline Engine Co., Anderson, Ind., makers of the Lambert with its "steel hoof" for traction aid; the Olmstead Gas Traction Co., Great Falls, Mont., manufacturer of the Olmstead with its "four wheel pull"; the Nevada Truck and Tractor Co., Nevada, Ia., makers of the Nevada Auto Plow; the Townsend Mfg. Co., Janesville, Wis., makers of the Townsend which resembled a steam traction engine; the Dauch Mfg. Co., manufacturer of the Sandusky; the Heer Engineering Co., producer of the Heer 4-wheel drive; the Parrett Tractor Co. producer of the Parrett Tractor (Fig. 18); the Imperial Machine Co.; the Fairbanks-Morse Co.; the John Lauson Mfg. Co.; the Michigan Tractor Co. of Detroit, manufacturer of the three-wheel drive, and the Heider Mfg. Co., later becoming a part of the Rock Island Plow Co., were among the companies that manufactured tractors for a short period.

The Heider tractor was unique in that it made use of a friction drive wherein a flat metal driving disk attached to the crankshaft of the engine drove a friction wheel by which the forward speed could be altered by moving the friction wheel toward or away from the center of the revolving disk—out from center to increase speed and vice versa. The above-mentioned Nevada Auto Plow was a three-wheeled machine with plows suspended amidships. This design permitted short turning in the field. Others of the same pattern that appeared in this period were the Opsata Motor Plow; Hackney; Gramont; Kardell; Rumely; Louisville Motor Plow; Lawter; Square Turn; Morton, and Boring. It is worthy of note that the Square Turn made use of power steering as early as 1917. It was effected by beveled friction pulleys.

A significant development of 1913 was the introduction of the Bull tractor (Fig. 17) by the Bull Tractor Co. of Minneapolis, powered by a small (12-hp) engine. This

started a trend toward smaller units, which practically all manufacturers of this period followed. Its importance was indicated by the fact that in 1913, the first year it appeared, several hundred were sold. In 1914 the company ranked first among all tractor manufacturers in tractor production, in 1915 second place, 1916 fourth place, 1917 seventh place, but in 1918 ceased production. It had one drivewheel, making differential unnecessary and an idler wheel mounted on a crank axle on left side for leveling.

In 1910 the Gas Traction Co. offered to the trade the Big 4 "30" (Fig. 19) with its 8-ft drivers; and in 1916 the Emerson-Brantingham Co. produced the E. B. 12-20, a three-wheeled machine that had two steering wheels in front and one driver in the rear. Both of these firms later became a part of the J. I. Case Co.

Also in 1910 the M. Rumely Co. started building the famous OilPull, a large tractor with a kerosene-burning, oil-cooled engine. It was sometimes referred to as "Kerosene Annie" (Fig. 20). This company later became a part of the Allis-Chalmers Co. (Rumely had also been a large manufacturer of steam traction engines.)

In 1911, the Minneapolis Steel & Machinery Co. put on the market its first tractor, the Twin City 40 (Fig. 21); the same year the Minneapolis Threshing Machine Co. introduced two models of tractors with different types of engines —the Minneapolis Universal of two-cylinder opposed and the Minneapolis 25 with 4-cylinder vertical; and in 1914 the Moline Plow Co. started production of the Moline-Universal (Fig. 22). This latter was one of the earliest practical approaches to a general-purpose tractor. A later edition of the Moline-Universal, the Model D, appearing in 1917, was probably the first tractor to make use of a storage battery for ignition, starting, and lighting. In 1929, these three companies were merged into the Minneapolis-Moline Power Implement Co., which in recent years became the Minneapolis-Moline Co.

In 1914 the B. F. Avery & Sons Co., Louisville, Ky., built its first Louisville Motor Plow (Fig. 23) but after a momentary success, sales fell off and its manufacture was discontinued. This company later became a part of the Minneapolis-Moline Co.

During this decade, while the large tractor seemed to be the predominant type, it could not accomplish the many tasks necessary to mechanize a farm—it could only plow, drive threshers, and pull large headers. However, much thought had been given to this situation and a number of manufacturers began experimenting with light tractors suitable only for cultivating (some eight or ten companies came out with such machines). However, light tractors did not fill the need, for two tractors were thus necessary on the farm, and this was out of line with the farmer's needs and pocketbook. Some machine was needed that would not only plow and thresh but, with proper attachments, would also cultivate, sow, and perform other field operations. This emphasized the need of an all-purpose tractor.

During this period experimentation continued on track-type tractors, and various models appeared: the Bullock Creeping Grip (1910) by the Bullock Tractor Co. of Chicago; the Yuba (1912) by the Yuba Co., Marysville, Ohio, with the tracks mounted on "balls that rolled in a race;" an improved model (1912) by Holt (Fig. 24); the Killen-Strait (1914) by the Killen-Strait Mfg. Co., Appleton, Wis., with two track drivers in rear and one front steering track; the Bates Steel Mule C (1916) by the Bates Machinery and Tractor Co., Joliet, Ill., with single track in rear for driving and two widely spaced front steering wheels (the model D, in 1918, had two rear driving tracks and two front steering wheels); the Trundaar, by the Buckeye Mfg. Co., Anderson, Ind.; and Leader (1917) by the Dayton-Dowd Co.; the Bear (1918) by the Bear Tractor Co., New York; the Cleveland H, 1918 (Fig. 25), later to become a part of The Oliver Corp.; the Monarch, 1918 (Fig. 26) by the Monarch Tractor Co., Watertown, Wis., later to merge with Allis-Chalmers, and the Best (1913) by the C. L. Best Gas Traction Co., Stockton, Calif., later to become part of the Caterpillar Tractor Co. It is of interest to note that during World War I the Holt Caterpillar tractor not only played an important role as an artillery and supply tractor, but also it was the inspiration of a British general who invented the "tank" which created such havoc among enemy troops and installations.

### 1920 to 1930

From the standpoint of development, the 1920 tractor, taken collectively, embodied fundamental engineering and designing found perhaps in more refined form in tractors of the present day. The one-piece cast-iron frame, replaceable wearing parts, force-feed and pressure-gun lubrication, enclosed transmission, carburetor manifolding, air cleaner, electric lighting and starting, the high-tension magneto ignition with impulse starter, enclosed cooling system, antifriction bearings, alloy and heat-treated steels, and the power take-off had all been introduced, and some experiments had been made with rubber tires. The lightweight low-price tractor had been designed and widely accepted, and several fairly successful motor cultivator-type units were on the market.

By this time the advantages of the tractor as a farm power unit had been well established, and the number of companies manufacturing tractors had passed the 160 mark and tractor production 200,000 units, compared with 15 and 4,000, respectively, in 1910. The number of tractor manufacturers reached a peak of 186 in 1921. Many makes and types of tractors were on the market and many were impracticable; and, in many cases, the farmer was the scapegoat. Fence corners were filled with useless so-called tractors, in many cases even before they were fully paid for. The situation became so bad that the State of Nebraska in 1919 passed a bill which, in effect, required that all makes and models of tractors to be sold in Nebraska pass certain prescribed tests. The testing procedure got underway in 1920 and, with modifications from time to time, has continued ever since, with the exception of the World War II years. These tests have since become significant, not only in Nebraska and the nation as a whole but also in many foreign countries. These tests have provided standards for rating tractors, have speeded up improvements on many of them, and have eliminated from the field many that were inferior in design and performance.

The depression that swept the country after World War I was reflected in the lowering of tractor production from 1921 to 1924, inclusive. The demand for tractors was also reduced, and this occasioned price cutting on most well-known makes. Although business was on the downgrade, several tractors of special interest nevertheless were produced.

## 1920 to 1929

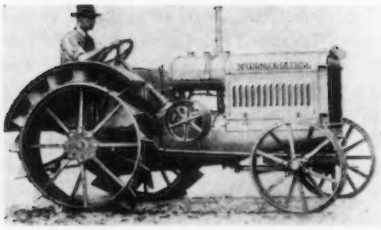

Fig. 27 McCormick-Deering 15-30 (1921)

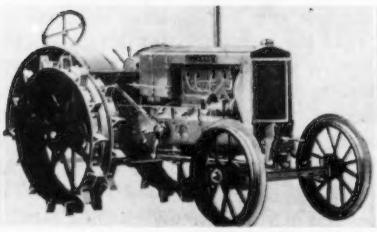

Fig. 28 Wallis "Certified" (1927)

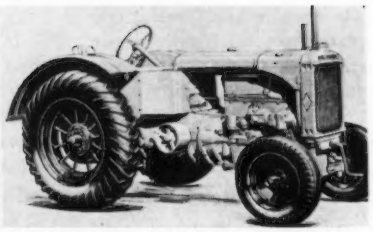

Fig. 29 Allis-Chalmers U "United" (1929)

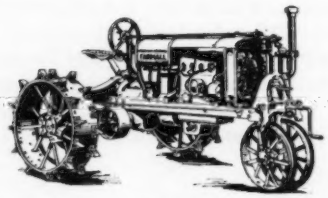

Fig. 30 McCormick-Deering Farmall (1924)

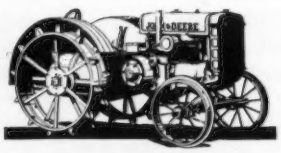

Fig. 31 John Deere D (1923)

In 1921 the International Harvester Co. introduced its 15-30 McCormick-Deering tractor (Fig. 27) with unit frame. The same year the Cleveland Tractor Co. introduced several styles of its Model F Cletrac tractors, one of which used a floating roller chain. Also in 1921 the Huber Mfg. Co., Marion, Ohio, introduced the Huber Super 4; the Allis-Chalmers Co. of Milwaukee, Wis., the Allis-Chalmers 12-20; and Russel & Co., Massillon, Ohio, the Russel Giant A.

In 1922 the General Motors Co., Detroit, Mich., discontinued making tractors. This firm had entered the farm equipment field in 1917 with the purchase of the Samson Sieve Grip Tractor Co., Stockton, Calif., but discontinued tractor production five years later.

In 1924 the International Harvester Co. produced the Farmall (Fig. 30), which was the first successful attempt at building a genuine all-purpose tractor. It could plow (two-plow size), cultivate four rows, and, as the attachments were developed, do other jobs. This development probably did more than any other advancement to broaden the usefulness of the tractor, and thus to further mechanization on the farm. The all-purpose tractor had high rear-axle clearance and small closely spaced front wheels to run between rows for cultivation and a hitch for attaching such equipment as a cultivator. The all-purpose machine was readily accepted by industry, as was soon evidenced by the appearance of such tractors variously designated as General-Purpose, Universal, All-Around, Row-Crop, Ro-Trac, Do-All, and similar names.

In 1923 Deere & Co. offered the rugged Model D tractor (Fig. 31), which was destined to become one of the company's main standbys. Then in 1928 it produced its first general-purpose tractor, the 10-20, with arched front axle and high-clearance rear axle and three-row planting and cultivating equipment. The year following the company put on the market its GP tricycle tractor equipped with a mechanical power lift for lifting integrally mounted implements. This was the first tractor so equipped.

During this period several four-wheel-drive tractors had appeared to offer some competition with the track-type tractors, such as the Wilson four-wheel-drive (1922) of Ottumwa, Iowa; the Wizzard 4-Pull (1926) of Los Angeles, Calif., and the Fitch Four Drive E-15-30 (1929) of Big Rapids, Mich.

Fig. 28 shows a 1927 Wallis (certified) 20-30 tractor. Fig. 29 shows a "United" tractor manufactured in 1929 by the United Tractor & Implement Corp., Chicago, which was later designated as the Allis-Chalmers Model U.

### 1930 to 1940

In 1930 the number of tractor manufacturers was 38; the number of tractors manufactured, exclusive of garden tractors, 196,297.

The large potential market for the general-purpose type tractor had now been realized. Several companies developed refinements to encourage buyers; these tractors included the Oliver tricycle row-crop tractor (Fig. 32) with its tiptoe wheels, the Massey-Harris FWD (Fig. 33), the Allis-Chalmers all-crop (Fig. 34), and the Case, all manufactured in 1930. In 1931 mechanical power farming slowed down, but despite a depression year several more companies made bids for the row-crop trade, such as Huber, Caterpillar with its high-clearance machine, and Sears, Roebuck and Co. Another advance this same year was that by the Caterpillar Tractor Co., which produced the Diesel 65, the first diesel-powered tractor in the United States to be put on the market. This proved to be such an important step that several companies began experimenting with diesel engines, and in 1934 several different makes of diesel-powered tractors appeared on the market. This development has since continued, and now most of the tractor companies have diesel-powered tractors in their lines. While the diesel-type engine depended on compression-ignition, in 1934 two firms, the Bates Machinery and Tractor Co. of Joliet, Ill., and the Allis-Chalmers Co., came out with a tractor powered with a Hesselman engine. This engine had spark ignition, although the compression ratio was not much different from that of the diesel, viz., 15 or 16 to 1.

Up to now the wheel tractor had been a rough rider. The farmer's work, in spite of this, had to be done, without

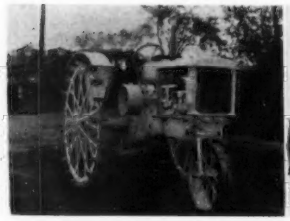

Fig. 32 Oliver Tricycle Row Crop (1930)

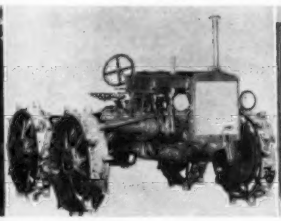

Fig. 33 Massey-Harris 25 Four Wheel Drive (1930)

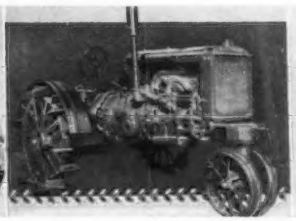

Fig. 34 Allis-Chalmers – All Crop (1930)

Fig. 35 International Harvester WD-40

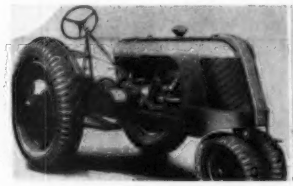

Fig. 36 Huber B

Fig. 37 Silver King Tricycle

Fig. 38 Minneapolis-Moline Universal Z (1937)

Fig. 39 Allis-Chalmers B (1938)

much time off to rest, and by night the farmer, pretty well shaken up, was ready for his bed. Soon, however, relief appeared in the nature of pneumatic tires to absorb the all-tiring shaking. These tires proved advantageous in several ways: they effected easier riding, they reduced vibration and caused less wear on tractor parts, they permitted higher field and road speeds, they reduced rolling resistance, and they effected more efficient operation.

The potential use of pneumatic tires was probably first noted by the citrus growers in Florida about 1928, where it had been noted the spade lugs of the tractors damaged the roots of the trees. These growers accordingly experimented with discarded casings on the steel wheels, which seemed to remedy the situation. The tire industry watched this development and in 1931 the Goodrich Co. brought out a zero-pressure tire. By 1932 several companies were experimenting with pneumatic rubber tires. In the lead was the Firestone Tire & Rubber Co., who fitted an Allis-Chalmers tractor with pneumatic tires. Their many advantages were so evident that rubber tires gained rapid acceptance. By 1935, 14 percent of the wheel tractors manufactured were mounted on rubber; by 1940, 85 percent, and by 1950, nearly 100 percent used rubber tires. Fig. 35 shows the International Harvester Co.'s WD-40 diesel-powered tractor mounted on rubber.

The depression years past, 1935 brought a marked return of business, and tractor production mounted to 161,000 units. In 1936 the production rose to 227,185 units.

The advantage of the use of water in pneumatic tires for the purpose of adding needed weight for traction was determined about this time. The water was intended to replace the iron weights attached to the wheels, which frequently caused trouble especially under high road speeds.

Streamlining, borrowed from the automobile trade, was becoming apparent on current tractors by most of the manufacturers. Among these were the Huber (Fig. 36) two-plow model and the Fate-Root-Heath Silver King tricycle general-purpose tractor (Fig. 37). In 1937 a tractor engine of

Fig. 40 John Deere L (1939)

Fig. 41 Ford with Ferguson System (1939)

unique design, powering the Universal "Z" tricycle-type tractor (Fig. 38), was produced by the Minneapolis-Moline Co. The engine had a detachable head that could be adjusted to alter the compression pressure by variation in size of the protrusions on this head. This was on the opposite side to the valves and contained the spark plugs and water jackets.

In 1935 Case tractors were being equipped with a "motor lift" for lifting and lowering implements. The lift functioned through an enclosed worm-and-gear set driven by engine power, actuated by stepping on a trip button. Among the tools developed for use with the motor lift were cultivators, 10-row truck-crop seeders, six-row beet planters, and 7-ft mower attachment.

In 1938 the Allis Chalmers Co. produced a tractor to sell under $500. This was the one-plow general-purpose Model B (Fig. 39), weighing less than 2,000 lb. It sold for $495 f.o.b. factory and was about the first small farm tractor to appear at this low-price level.

The year 1939 saw several companies putting out new models, streamlining them in many cases for better vision ahead, and, in the wheel types, using a tricycle design or a four-wheel with adjustable front and rear axles. In 1939 Deere & Co. departed from their regular horizontal engine design to a two-cylinder vertical, the Model L (Fig. 40).

A development that was destined to improve greatly the usefulness of the tractor was the 3-point hydraulic hitch developed by Harry Ferguson in Ireland and brought to this

## After 1940 (Figs. 45 to 55 are 1957 models)

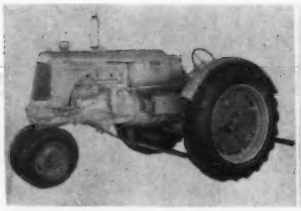

Fig. 42 Minneapolis-Moline Butane

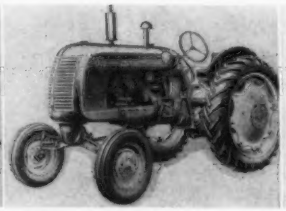

Fig. 43 Cockshutt

Fig. 44 Deere MC

Fig. 45 International 650

Fig. 46 Deere 620

Fig. 47 Case 600

Fig. 48 Oliver Super 99 GM Diesel

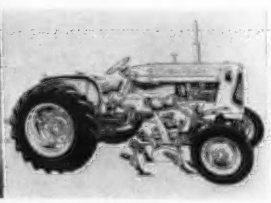

Fig. 49 Allis-Chalmers D-14

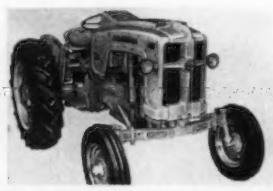

Fig. 50 Minneapolis-Moline 335

Fig. 51 Ford

Fig. 52 Massey-Harris 444 Diesel

Fig. 53 Ferguson Hi-40

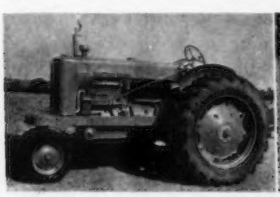

Fig.54 Sheppard Diesel SD-4 TC

Fig. 55 Caterpillar Diesel D-4

country in 1939 after many years of experimentation. It was a revolutionary easy method of implement control—so much so that the whole trend of design of farm tractors and equipment in the ensuing years has been greatly influenced by the appearance of the Ferguson system. After a demonstration before Henry Ford, a working agreement was established between Mr. Ford and Mr. Ferguson for mass production of a tractor incorporating the Ferguson system. More than 300,000 tractors were built under this arrangement between 1939 and 1947. Fig. 41 shows the Ford tractor with Ferguson system. Late in 1947 the agreement between these two men was terminated, and each came out with his own tractor.

### 1940 to 1950

The number of tractor manufacturers in 1940 is not known, but the number of tractors manufactured (exclusive of garden tractors) was 274,196.

The use of another type of fuel for tractors—LP (liquid petroleum) gas—appeared early in this period. The Minneapolis-Moline Co. came out with a standard tractor fitted at the factory for burning LP gas, the Minneapolis-Moline Butane Fig. 42). Previously some of the companies had offered conversion kits for converting the tractors in the field from gas or kerosene to LP gas. This LP gas, a light end of the crude oil, had been largely a waste product until means had been developed to liquify it by compression. Although as bottle gas it had been considerably used throughout the country, as a tractor fuel its most economical use seemed to be in or near the petroleum-producing regions. A number of tractor manufacturers have since come out with tractors fitted with such equipment designed and built at the factory.

In the World War II period, beginning late in 1941, experimental work on tractors was again curtailed and few new models appeared. Many tractor plants were converted into munition factories and plants suitable for making war materials. When peace came in 1946, a year or so was required to reconvert the plants back to the manufacture of tractors and related equipment.

Some experimental work, however, had been under way, as a marked improvement in power take-off design for its tractors (Fig. 43) was offered by the Cockshutt Plow Co., Brantford, Ontario, in 1947. This was a continuous running power take-off (direct-engine-driven PTO), which continued to operate even when the clutch was released. Heretofore, machinery operated by the regular PTO (power take-off) such as sprayers, drawn corn pickers, and PTO combines would stop upon release of the clutch. Continuous running PTO was soon to appear on the tractors of most manufac-

turers. The Oliver Corp., as a part of its centennial celebration, announced a new and improved line of tractors, one feature being the continuous running PTO, probably the first wheel-type tractor to be thus equipped in the United States.

Also in 1947 Allis-Chalmers offered to the trade its Model WD tractor fitted with most of these recent developments: The live power take-off; five-way hydraulic control system that permitted *(a)* raising or lowering an implement, *(b)* holding implement in desired position, as mower cutter bar, *(c)* regulating working depth of plow or other implement, *(d)* delaying lifting or lowering of rear tool bar to permit full cultivation to the end of the row (delayed action), and *(e)* automatically controlling draft-balancing load with power; and the first device for power adjusting the rear wheel tread. The latter mechanism permitted the operator to use the engine power for altering rear wheel spacing while sitting on the tractor seat. This was effected by the use of tire rims equipped with spiral guide rails operating in flanges bolted to the wheel disks. This development removed the strenuous job of making the alterations by the hand-and-jack method and at a considerable saving of time.

In 1949 Deere and Co. produced its first diesel tractor powered by a twin horizontal engine with 16-to-1 compression ratio and its first track-type tractor, Model MC (Fig. 44) powered by the same 20-hp engine.

In 1949 the R. H. Sheppard Co., Hanover, Pa., marketed its first diesel-powered tractors, including an air-cooled one of one 12-in plow capacity. While the first Sheppard model had been ready in 1940, the war prevented earlier marketing. This was about the only company that specialized in diesel tractors only. They even had diesel engines available for replacing gas engines on several well-known makes of tractors.

### 1950 to 1957

In 1950 the number of tractor manufacturers was 45, and the number of tractors manufactured (exclusive of garden tractors), 542,448, exceeded only in 1948 when 33 manufacturers produced 569,000.

By the beginning of this period some tractor manufacturers had already incorporated in their tractors a number of the special features that had been appearing from time to time and others were in the process.

It has generally been conceded that before an invention or development comes into general use some 10 to 15 years elapse—in many cases no doubt with the expiration of patents. Whatever the reason, the full-line companies at least were redesigning their tractor lines not only to include, as one prominent engineer put it—"the four outstanding developments in the period 1920-1950; the power take-off, pneumatic tires for tractors, general-purpose or cultivator tractors, and hydraulic controlled mounting equipment," but also such items as an improved hitch, live power take-off, torque amplifiers, fluid couplings, synchro-mesh transmissions, remote control of drawn implements, and power steering. In addition these companies were adding LP gas-burning tractors, diesel-powered tractors, and crawler-type tractors to their lines. Universal use had already been made of electric starting and lighting, although some manufacturers had begun using 12-volt batteries in place of 6 volt.

In 1954 a new source of farm electrical power was announced by the International Harvester Co. for mounting on its tractors, the Electrall. This development was to supply power for tractor-drawn machinery such as hay balers, and for farming operations where the utility companies' wires did not reach. It could also serve as a standby unit in case of outage of electric service occasioned by storms or other emergencies. The Electrall system derived its power from an alternating-current, synchronous generator, designed and built by General Electric engineers. It was provided with three outlets which supplied *(a)* 220-volt, 3-phase 60-cycle a-c mainly for driving electric motors, *(b)* 120-volt, single-phase current to hitch to house wiring circuits, and *(c)* 220-volt single-phase current for such heavy load requirements as the electric range. The generator was mounted on the right side of the tractor and was driven with suitable drive from the tractor engine.

Since 1952 many smaller companies have been producing tractors and offering considerable competition in the small tractor field, and while space does not permit discussing the various models, they should at least be recognized, such as the Westrak by the General Tractor Co., Seattle, Wash.; Cimco by the Consolidated Implement Co., Ogden, Utah; the Simpson Jumbo by the Jumbo Steel Products Co., Azusa, Calif.; the Detroit (four-wheel-drive) by the Detroit Tractor Corp., Detroit, Mich.; the Long by Long Mfg. Co., Tarboro, N. C.; the Co-op by the National Farm Machinery Cooperative, Inc., Bellevue, Ohio; the Love by the Love Tractor Co., Eau Claire, Mich.; the Haas Atomic by Metal Parts Corp., Racine, Wis.; the Brockway by the Brockway Tractor Co., Chagrin Falls, Ohio; the Farmaster by the Farmaster Corp., N. Y. City; Earthmaster by the Earthmaster Farm Equipment Co., Hollydale, Calif.; the Friday by the Friday Tractor Co., Hartford, Mich.; the Laughlin by the Laughlin Tractor Co., Marshall, Tex.; the Gibson by the Gibson Corp., Longmont, Calif.; the Custom by the Custom Mfg. Corp., Shelbyville, Ind.; the Terratrac by the American Tractor Corp., Cherubusco, Ind.; and the Powerbuilt (four-wheel drive) by the General Tractor Corp., Detroit, Mich.

### A Tribute

This story would hardly be complete without paying tribute to the many who have had a hand in bringing the agricultural tractor through the rocky road of disappointment, discouragement, and often failure to its present high state of development and efficiency. Many are the engineers, designers, and others who have worked long hours in the machine shop, in the field, over the drafting board, and on the farm with the farmer—where the end product was to go. All have unselfishly contributed, and collectively their efforts have been crowned with the appearance of the current models of tractors — streamlined, efficient, multipurpose and easy to handle — with many safety features built in.

It is therefore fitting and proper this year while the American Society of Agricultural Engineers is celebrating its Golden Anniversary that special recognition be accorded all agricultural engineers for their outstanding contributions in many fields, and especially to those of industry and public service who have devoted so much of their time and energy to bring about the present advanced stage of farm mechanization.

# Fifty Years of Farm Machinery

**H. F. McColly**
Member ASAE

*"High production per man with labor-saving, cost-cutting equipment has brought a better way of life for all. It has made America a Land of Plenty." Farm Equipment Institute*

FARM machinery increases the efficiency of the agricultural industry. It enables farmers to respond to new opportunities, to make adjustments in their enterprises or to change their methods, and to transform farming from long hours of drudgery to less arduous effort, yielding more time to enjoy good living in modern buildings equipped with modern conveniences. The importance of farm machinery in the development of agriculture is realized when reviewing agricultural history and noting the extensive references to the agricultural implements of any given period and their effect upon the agriculture of that time.

When the American Society of Agricultural Engineers came into being in 1907, threshing machines were operated by steam engines. The horse as a farm draft motor had little competition. The word tractor had just come into use, and the contrivance was looked upon as an intruder. Agriculture was in an era of transition from animal power to mechanical power.

During the animal power period, considerable progress was made in developing farm machinery. As the tractor started to enter the scene, there was a great deal of effort spent on improving and enlarging animal-drawn machines. Larger machines drawn by more animals in the hitch were quite successfully used before the tractor took over.

## Tillage Implements

Foot-lift sulky and gang plows were developed only a few years prior to 1907, although during this same period, walking plows and lever-lift riding plows were common on farms. On large farms and in the prairie areas, steam traction engines pulled gangs of a dozen plows or more.

Horse-drawn gang plows of about 1915 boasted many engineering developments over their earlier counterparts. Steel parts replaced malleable parts, pieces were made heavier and stronger and quick-detachable shares and improved wheels, axles, bearings and sand collars were introduced. Some early tractor plows were horse-drawn two or three-bottom gangs fitted with a tractor hitch instead of a horse hitch.

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*Improved Tractor Plows Appear*

Prior to 1915 tractor plows generally had chain hitches which did not permit backing of the plow. The curvature of the beams provided little clearance for trash over the moldboard. About 1915 unit frame tractor plows were introduced which included heavier beams and braces which served as the frame. The rear wheel provided a high and level lift, a stiff hitch replaced the chain hitch, beams had several inches more throat clearance, and bottoms were spaced farther apart providing greater clearance for trash. The power lift also made its appearance in 1915 and in the following years of plow development much of the work dealt with lift clutches, wheel improvement — particularly the power wheel, and break-away devices in the hitch to soften the shock on the plow in rocky conditions. The first break-away devices consisted of wood break pins, later replaced by spring release hitches.

*Lift-Type Tractor-Mounted Plows*

In the mid-1930's one and two-bottom lift-type tractor mounted plows were introduced, and this development has continued with as many as four or more bottoms now being lifted. In the early 1940's, hydraulic remote control was applied to tractor plows and other drawn implements. Recently, trip-type bottoms and spring trip attachments have been developed to protect the plow when striking obstructions in the soil. New developments in mounted plows include devices to increase penetration effects by tractor weight transfer or by hydraulic pressure. High speed bottoms are also common on present day tractor plows enabling good plowing at higher rates of ground speed than common a few years ago.

Two-way plows—in reality ⊢ ⊃ plows (one with right-hand and one with left-hand bottoms) which can turn all furrows in one direction without leaving a dead furrow—also became mounted implements of increasing importance in the 1940's. Disk plows followed the same improvements as moldboard plows, and their use has become more common in terrace building and other types of farming areas in addition to hard and sticky soil areas.

Irrigated farming areas, about the turn of the century, had the introduction of a variety of deep tillage tools including subsoilers, spring-tooth harrows and cultivators and specialized equipment like border ridgers, furrowers and ditchers.

Combination tool carriers, which enable the use of a variety of tillage tools on the same carrier, were introduced in 1921 and the popularity of this type of equipment is increasing and expanding to include crop planters. Heavy-duty offset disk harrows popular for both orchard and field use were first produced commercially in 1924.

Listers and middlebusters were improved in much the same manner as plows, but both tool carrier and unit ma-

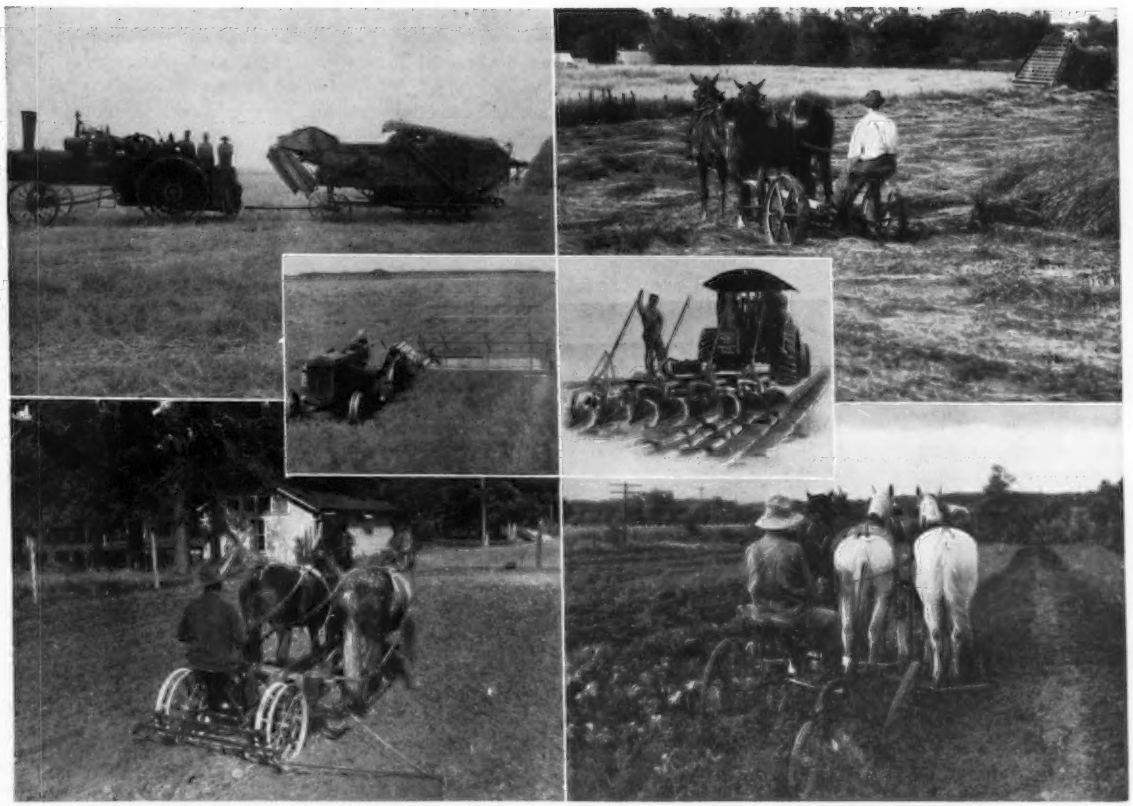

Fig. 1 Early agricultural engineers worked with these types of machines. *(Top)* Steam threshing outfit ready to go to the next job. Horse-drawn mower and wagon hay loader outfit saved much pitching labor. *(Center)* The tractor-drawn grain binder, preceded the adoption of the combine. Gas tractor and chain hitch plow. *(Bottom)* The check row corn planter enabled cross cultivation of corn. The sulky plow took the plowman off his feet.

chines were popular and continue so although the multi-bottom tool carrier type is gaining in popularity.

*Summer-Fallow Tools*

In the far west many summer-fallow tillage implements were developed. The rod weeder consists of a rod slipped or rotated under the soil surface to control weed growth and maintain a cloddy surface. Field cultivators equipped with duckfoot shovels were originally horse drawn. Later, field cultivators were tractor drawn and covered widths of 10 or more ft.

In the early 1920's, the one-way or wheatland disk underwent considerable development and in 1927 they started to be sold in large numbers in the Great Plains. It was developed primarily to do shallow plowing, mixing stubble with the soil to prevent erosion, and to cover about twice the width of cut of a moldboard plow with the same power requirement. Seeder attachments were developed for seeding wheat at the time of tilling. Recently lighter tractor-mounted models have been introduced.

*Cultivation*

Row crop cultivators in the early 1900's were primarily single-row and two-row horse-drawn implements. Three and four-horse two-row cultivators became quite common in the corn belt between 1910 and 1924. Generally the cultivators were equipped with shovels and sweeps, but surface blades, spring teeth, disks, rotary hoes, and other attachments also were used.

The rotary hoe got into commercial production about 1912, over 20 years after its invention. It gave farmers a wide fast tool for early cultivation that did not require precision operating in regard to rows. Tractor power made the rotary hoe popular because motor cultivators about 1915 were not completely accepted. The development of the tricycle-type tractor in 1924 started the development and acceptance of the tractor cultivator. These tractor-mounted units were one, two, and four-row cultivators for wide-row crops like corn, cotton, potatoes, and peanuts. From one to six-row outfits were used for sugar beets, beans, vegetables and other close-spaced crops. Tool carrier cultivators are particularly popular in close-row crop tillage. Choppers and thinners used for cotton, sugar beets and other crops which are difficult to "plant to a stand", not only thin but actually cultivate the crop.

## Planting Machines

Grain drills, before the beginning of the 20th century, contained many of the mechanisms which are common devices today. Such items as a lever for throwing the drill in and out of gear while in motion and the multiple-row bevel gear for seeding quantity control had been developed. Others included double-run force-feed, fluted force-feed,

zig-zag opener ranks, fertilizer and grain seed attachments, hoe-type furrow openers, and double-disk and single-disk furrow openers.

As animal power gave way to tractor power, the grain drill became a tractor-drawn machine; at first simply substituting a tractor hitch for the horse hitch. The more rugged, higher-speed operation necessitated pressure-feed lubrication, low-friction bearings, high-carbon steel parts, stronger frames and wider widths of seeding. Attachments for seeding other kinds of seeds in addition to cereals were developed. Furrow drills for dry farming sections which placed seed in the bottom of specially prepared furrows also were developed.

*Corn Planters*

The accumulative or hill-drop planters of the 1890's were undergoing improvements 50 years ago. The early machines were strengthened and refined, and the accuracy and versatility of the work greatly improved. The automatic marker came into being. Simple attachments for distributing fertilizers simultaneously with the planting of the corn followed closely the development of successful planters. In the years following, better clutches and sprockets, as well as check wire forks and rollers were notable improvements.

The introduction of the row-crop tractor in 1924 brought the development of multirow planters. The first planters of this type consisted of two horse-drawn two-row planters held together with a suitable hitch. Development followed rapidly and both two, three, and four-row machines were developed and improved. Planters pulled by tractors and power-lift planters for mounting on tractors were introduced, and these machines permitted planting or drilling on uneven or terraced land. Planters for planting on ridges, on level land, or in lister furrows and for various soil characteristics received much attention. Seed hoppers with interchangeable seed plates were built for handling all kinds of corn, milo, peas, beans, peanuts and other seeds of comparable size. Attachments for placing fertilizer in bands made their appearance in 1929.

*Other Planting Machines*

Planting machines like potato planters, transplanters for tobacco and vegetable plants, cotton planters, vegetable drills, grass seed drills, and others were in use prior to 1900. Up through the years their development kept pace with other farm machinery advances.

Cotton planters and corn planters often were improved simultaneously and in some cases were the same planter with interchangeable seed hoppers and other parts. Potato planters in 1907 were in rather common usage in potato production areas, although producers with smaller acreages prepared furrows with furrowers or cultivators, deposited seed by hand, then turned the furrow full of soil. Two-row potato planters were on record in 1917. As other planting machines improved, the potato planter was improved accordingly.

Single-seed beet planters were developed and made commercially available in 1939. In 1942 the first commercial plantings of segmented beet seed were made, which was a rather easy step in the single-seed planter development. Recent efforts with sugar beet planters are applied in soil treatments to obtain better seedling emergence.

Modern planters are developed to enable accurate plant-

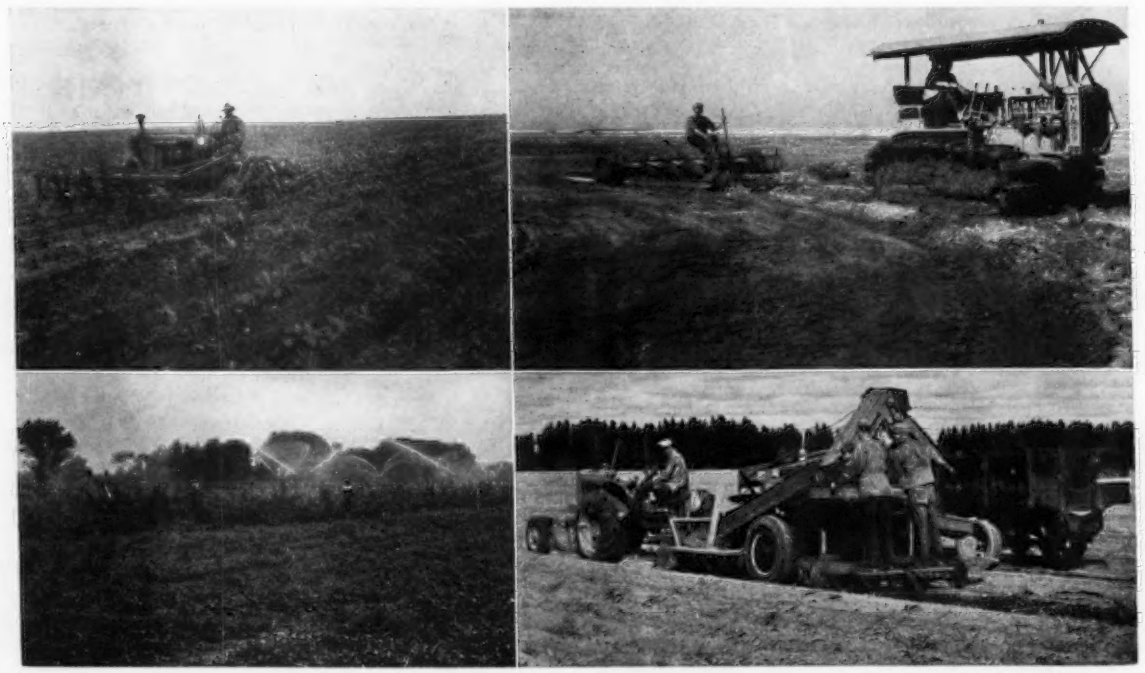

Fig. 2 *(Top)* The general purpose tractor made row crop production with tractor power a success. Land leveling, first practiced in rice fields, also has been used successfully for other irrigated crops. *(Bottom)* Portable sprinkler irrigation in the 1930's started active expansion in this form of mechanization. Potato harvester digs and delivers clean tubers either into truck or sacks

Fig. 3 The combine in the 1930's started to sweep the country as the grain harvesting method. The field pickup baler *(right)* was the forerunner of today's one-man automatic machine

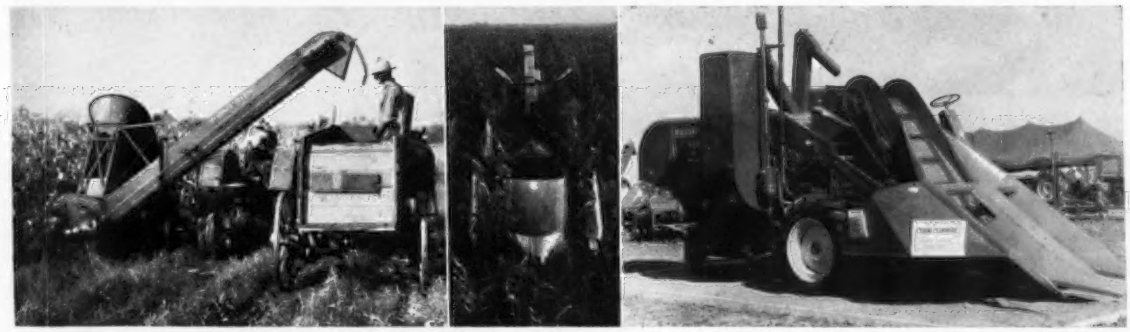

Fig. 4 This field ensilage harvester led to the development of field forage harvesters for both corn and grasses. *(Center)* The two-row mounted corn picker of the 1930's became popular due to its streamlined handiness. The corn header attachment developed in the early 1950's for the grain combine makes a self-propelled picker-sheller

ing and spacing at operating speeds above 4 mph. Corn planters with zero pressure pneumatic press-wheels in front of the furrow opener, seed press-wheels, and row press-wheels designed to plant in soil prepared by minimum tillage, often on the plow furrows, are interesting current developments.

## Grain Harvesting

Shortly before 1900 the apron type grain thresher gave way to the vibrating straw rack type of thresher. The apron type consisted of an endless apron of wood strips nailed on canvas, the canvas carrying the seeds and the strips conveying the straw. A raddle rake vibrated by square pulleys and cam-shaped bumpers, and shaking shoes aided in completing the separation. The vibrating straw rack, appearing in some machines about 1858 and used in threshers up through the years, consisted of successive ranks of lifting fingers to which was imparted a sudden up-and-down motion that thoroughly agitated the straw immediately after leaving the cylinder and until it reached the rear of the machine.

In 1904, the first steel thresher appeared and it was vigorously contested. By 1933 the steel thresher was the type manufactured by most builders. The early threshers, of about the 1907 period, had no material change in design since some time in the 1850's. Developments were principally in supplemental devices like feeders, wind stackers, grain weighers, band cutters, etc.

Shortly after 1900 the steam engine, which was a part of a threshing rig, gradually gave way to the gasoline traction engine. Threshers were built in smaller sizes to accommodate the farm gas tractor. The thresher itself has given way to the combine until now it is increasingly difficult to locate manufacturers of threshing machines. Thus has ended a symbol of the earlier days of farm mechanization—the threshing crew.

### *Grain Binders*

The grain binder represented a great advance in harvesting machinery. The binder in the early 20th century was constructed with nearly all parts of iron and steel, although some parts were of necessity made of wood and canvas. More emphasis was placed on building the machine lighter, widening the wheels, reducing draft by use of better bearings and axles, and incorporating adjustments for cutting-height, reel position, elevating the grain and tying the bundles.

It was possible to cut wider swaths as the machines decreased in draft requirements and horse-drawn machines with 8-ft cutterbars were common by 1920. The advent of the tractor encouraged 10-ft cut tractor-drawn binders built more ruggedly than their horse-drawn predecessors.

The grain binder was hardly out of the experimental stage before the successor to it foreshadowed its replacement. The combined harvester-thresher, a machine which cuts, threshes and cleans the grain in one operation, appeared almost simultaneously with the reaper.

Early combines of about 1910 were largely built of wood panels and frames and were cumbersome heavy-draft

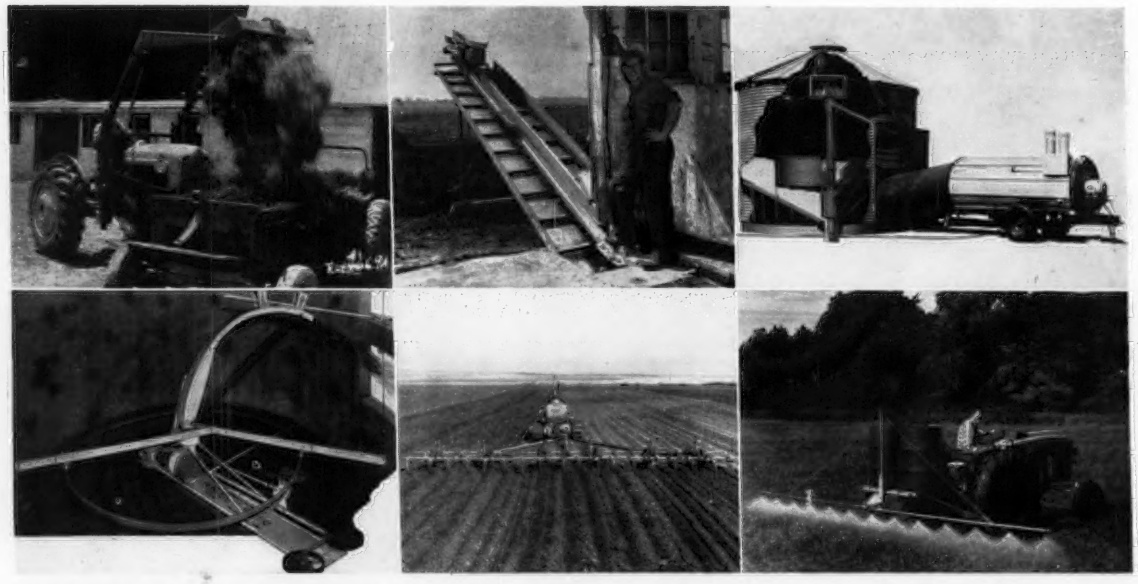

Fig. 5 Recent developments in farm equipment save labor and improve crop quality. *(Top)* The tractor loader developed in the late 1930's is today a necessity on the livestock farm. Cleaning the stable is now a push-button job. Recirculating grain drier and oil-fired portable crop drier enable today's farmer to obtain higher quality grain. *(Bottom)* The mechanical ensilage remover saves climbing the silo and digging ensilage loose. Field cultivators up to 45 ft wide are available. Farm crop sprayers are found on nearly every farm

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machines. As many as 40 horses or mules were required to draw them.

Steam traction engines were also used to pull the early combine, and steam engines as auxiliary engines on the larger machines were used in attempts to maintain uniform combine speed regardless of the speed of forward travel. To meet the rolling land conditions of the western wheat areas, the hillside combine was developed which had a leveling device.

About 1912 steam power began to be replaced by gas power as a means of operating the combine as well as moving it forward. Steel instead of wood construction was becoming more common, and the machines became lighter and easier draft. Also machines with narrower widths of cut made their appearance for use on smaller acreages.

During the 1920's and early 30's big combines were predominate, those 10 ft and over in size outnumbered by three to one those under 10 ft. In 1935 the one-man combine powered by a two-plow tractor permitted the combine method to become nationally accepted, and the more laborious expensive binding - shocking - threshing method gave way. Thus, the smaller combine came into prominence.

The combine on the farm has permitted harvesting grass and legume seeds, beans and grain sorghums in addition to small grains. Combine harvesting aided in expanding soil conservation practices due to the grass and legume seed harvested. Soybeans and sorghums have become major crops today due principally to the producer having his own harvester and thresher, the combine.

*Self-Propelled Combines Developed*

The self-propelled combine appeared in 1938 and in a few years machines smaller than 10-ft cut were popular. The self-propelled machines and the great number of pull-type one-man machines did much to help meet World War II needs for food. A U.S. Department of Commerce bulletin said, "Without the combine, bread rationing in the United States would have been inevitable."

During the early 1950's the corn picker attachment was developed for the combine which enabled picking and shelling corn in a convenient one machine operation. Earlier picker-shellers were corn shellers towed in tandem to corn pickers.

Picker-shellers accentuated the demand of farmers for crop driers. The crop drier, widely used as a hay drier, was expanded into use for grain drying. Grain crops could be cured in the field for safe storage, but farmers desired to avoid weather hazards by earlier harvesting. The picker-sheller method requires a crop drier, thus many farms use the drier for all three types of crops—hay, small grain, and shelled corn.

With the advance of materials handling equipment on the farm there is a development of a crop drying system on many farms. This development will increase making it possible for farmers to further decrease the hazards of harvest and storage of farm products.

*Corn Shellers*

Successful corn shellers had been in existence only about five years before 1907. These machines followed about the same general pattern of improvements as threshers. Steel machines replaced those built with wood frames and panels and were quite common by 1932.

Corn husker-shredders underwent considerable improvement throughout the early 1900's and were quite popular due to the shredding of the stover for feed and bedding, together with the husking of the ear. Undoubtedly some farmers felt about 1910 that the husker-shredder would be more popular than the corn picker which at that time had numerous field breakdowns.

Corn binders were a counterpart of husker-shredders as well as for silo fillers. Bundle corn was often shocked as fodder and fed from the bundle or husked out by hand in the winters, or chopped by means of fodder cutters.

*Corn Pickers*

The corn picker was built commercially in 1909 and many hand-huskers longed for the day of the successful operation of the machine. In the 1920's the machine began to be used more extensively, especially when the PTO shaft of 1919 became available for the pickers. In 1928, the two-row PTO-operated corn picker and one-row mounted picker, followed by the two-row mounted picker in 1929, became realities.

**Cotton, Sugar Beet and Potato Harvesters**

Although the cotton harvester had been under development for many years, it was not until World War II that its use became established. In 1941 the cotton picker was stated to be successful and its use has since spread rapidly.

Potato diggers developed from horse-drawn plow-type implements of the 1870's into the potato harvester of the 1940-45 period. This machine enabled digging the crop, and elevating it to sorters and baggers.

The development of the sugar beet harvester was beset with many problems. The sugar beet was hard to top, loosen from the soil, clean and elevate into a vehicle. By 1943 sugar beet harvesters were used in appreciable numbers and today the greatest percentage of sugar beets are harvested mechanically.

**Hay and Forage Harvesters**

The farmer of 1907 could choose his hay and forage harvesting implements from several types. Mowers, dump rakes, tedders, side delivery rakes, hay loaders, hay carriers, hay presses, sweep rakes, portable hay stackers were all available, some with several decades of development activities.

*Mowers*

Undoubtedly the mower of the time was a 5-ft horse-drawn machine. For several years the general design and appearance of the mower did not change greatly, but there was gradual improvement throughout the years, mostly improvements in materials, strength, and ease of repair. In 1915 the mower had many parts increased in size, some were carburized and heat treated, and wearing plates were improved. The automatic take-up on the pitman at the knife-head ball appeared about 1919. Changes in the cutting mechanism which affected cutterbar alignment and knife section registration were of great importance.

In the late 1920's and early 30's there was more attention given to better lubrication and dust-tight gear housings. The continuous oil bath for gears, clutches, drive pawls and ratchets were important changes of note. This progress led to both roller and ball bearings and higher speed operation.

The first tractor-drawn mowers were horse-hitch machines equipped with tractor hitches, but successful tractor mowers demanded more rugged streamlined design and higher speed cutterbars. The farm tractor PTO of 1919 through its years of development was applied to the mower. In the mid 1930's it was common to find two types of tractor mowers. One was the pull-behind machine, and the other an attachment carried entirely on the tractor. A drawbar-attached mower driven by PTO became popular. All mowers operated by tractor power had safety devices enabling the cutterbar to trip rearward upon striking obstructions, and a slip clutch to protect the cutterbar in case of clogging.

By the year 1935 various attachments for use with or on mowers were developed. Reaper attachments, bunchers, vine lifters, stub guards, special weed attachments, tongue trucks, and knife grinding attachments were common.

The mower-crusher for speeding up the field curing of hay was announced early in 1946. The crushing unit consists of pressurized rollers immediately behind a pickup device which elevates the grass directly from the cutterbar into the crushing rolls. Other adaptations followed rapidly, some units being pulled behind the tractor which enabled the swath to wilt one round before being crushed. Crimpers made with corrugated rolls or cog-like flutes have appeared recently until today there are quite a variety of hay crushers and conditioners available which crack the stems permitting moisture to escape rapidly and thus decrease the time required to field-cure hay.

*Rakes and Tedders*

The use of the mowing machine demanded a more expeditious means of raking hay. This led to the development of tedders, sulky or dump rakes, side delivery rakes and sweep rakes. All were available in 1907.

The tedder was popular as a mechanical means of shaking up and moving hay that had laid out in the rain and needed turning so the sun could cure it. The tedder could loosen a heavy hay crop after mowing to aid more rapid and even curing. The mechanism consisted of a number of two or three-tined forks driven by a crank which lifted and tossed the hay backward.

The hay tedder has been largely replaced by the side delivery rake, because as clover and alfalfa hay increased in acreage, it was necessary to handle these hays more gently to preserve leaves and fine stems. Some early side delivery rakes also contained tedder arrangements, usually a means of reversing the rotation of the rake cylinder which had straight teeth. Sometime in the 1920's, side delivery rakes were equipped with curved teeth in order to more gently move the hay into a windrow.

The simplest of the wheeled rakes was the dump or sulky rake. The machine most common in 1907 was a hand dump implement, with external ratchet on the ground wheels which had the fault of repeating the dumping cycle and the consequent winding up of hay. After 1910 the internal ratchet was placed in the ground wheels, the dumping device was foot tripped, materials were improved in quality, and the rake was termed a self-dump rake.

*Hay Tools Many and Varied*

Before 1900, many forage harvesting and handling machines had been introduced such as the harpoon type hay fork, the hay carrier, hay press, hay loader, ensilage cutter, portable hay stacker, and sweep rake. Hay harvesting systems varied throughout the country. In some sections the side delivery rake, hay loader, and hay carrier were common. In others the dump rake or side delivery rake, the sweep rake and stacker were selected, while in some areas the dump rake, pitch fork and either hand stacking or the barn loft carrier was the method preferred.

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In 1932 the field pickup baler appeared and four years later the forage harvester was built commercially. The blower part of the ensilage cutter was developed into a forage blower, and in the 1940's the grain elevator received considerable attention as a machine for filling silos and elevating chopped hay into the mow.

Lately the forage chopper has become available as a self-propelled machine, and the self-unloading forage wagon has gained in popularity. Field balers are now high-speed high-capacity machines.

### Specialized Equipment

In 1910 electric water systems were produced in quantity after four or five years of experimentation. Today, a pressure water system is one of the standards of good living on the farm. About 1926 the jet pump for home water systems was introduced on the Pacific Coast.

Farm machinery has enabled the farmer to produce the field crops with less man-hours. Much of the saved time goes into more diversified and specialized farming operations; more livestock, poultry, and specialty crops which have added to the farm income and contributed a major share of the total farm income.

*Mechanical Equipment Aids the Animal Industry*

Dairy farmers have made increasing use of the milking machine which had its early improvements about the turn of the century. Power-operated milkers were developed in the period around 1914 to 17. Ground and chopped feeds spurred the adoption of feed grinders and choppers. The hammermill was introduced in 1920 and had rapid adoption for several years thereafter.

The manure spreader, which is a common symbol on the livestock farm, changed through the years from a horse-drawn machine to a steel box pneumatic-tired tractor-drawn vehicle. Also noted is the availability of large capacity spreaders. The tractor-powered manure loader was built commercially in 1938 and this machine has saved farmer's arms and backs. In 1937 the automatic barn cleaner became of commercial importance enabling the stanchion barn dairyman to clean the stable mechanically.

About the turn of the century feed and litter carriers were undergoing development. Steel stanchions followed shortly, and these were made with an alignment device enabling adjustment forward or backward for large or small cows.

In 1912, automatic individually operated drinking cups were introduced. The electric ventilating system appeared in 1924. These two devices kept cows more comfortable and increased milk production.

About 1900 the poultry industry consisted of a scattering of 25-bird flocks, although some attention was being given farm poultry. The colony-type heated brooder introduced in 1910 soon put the setting hen out of business because this device could properly care for the chicks hatched in the incubator. Incubators had been under development for about 25 years before the introduction of the colony-type brooder, and many early poultrymen can recall developing "broody" hens to brood the incubator chicks.

*Sprayers*

In the early 1900's the power sprayer replaced the irregular power furnished by traction wheels. The pressure-controlled regulator appeared in 1911 and eliminated the pulsating action sprayers. The air blast principle was first tried in 1925 and is widely used today in mist sprayers.

Dusters have been developed for applying protective dusts to farm crops and some machines will blow atomized liquids into the dust air stream. Machines yielding dust particles charged with static electricity are experimental at this time. Low pressure low volume sprayers for weed control have become common. Today, practically every farm has a sprayer or duster where formerly they were employed primarily for orchard, grove and vineyard.

*Garden Tractors*

The introduction of the garden tractor in 1916 hastened the development of vegetable tools including precision planters which came along in 1941. Mowers, soil tillers, cultivators, snow plows, fertilizer spreaders, carts and many other attachments have been developed for the garden tractor.

Originally the garden and lawn tractor was found primarily on vegetable farms and nurseries. Now it is most common to find a garden tractor on the larger farms, used for the family gardens, lawn mowing and fence row trimming.

### Extensive Developments Made

Great advance has been made in the character of the materials employed in farm machinery, and in the design and construction features. Farm machinery changed from predominantly forged and cast assemblies with slow speed gears, chains and other parts to mechanisms utilizing pressed and stamped steel, welded structural members and higher speed shafts, bearings, gears, chains and V-belts.

Developments in the production and use of farm machinery have been numerous and extensive in the last half century. These developments are continuing and in most cases accelerating, thus creating a changing, advancing and challenging situation.

In 1957 each worker in agriculture is producing enough food and fiber to support over twice the number of persons at home and abroad that he supported 50 years ago. The increased productivity has resulted largely from increased use of efficient and improved agricultural machines.

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# Drainage Developments During the Past 50 Years

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PROGRESS in drainage during the last half century is measured by the area of productive land improved for agricultural use, by the farms and villages created from wet and swamp lands, and by the improvements in design and construction techniques and methods. From the data available, it is estimated that about 30 million acres had been drained through organized drainage enterprises prior to 1905. However, during the period 1905 to 1909 a large increase in drainage activity took place, in which about 15 million acres were drained through organized drainage enterprises. According to the 1950 Census, a total of 102.7 million acres had been drained by 1949 in enterprises of 500 acres or more in size. The location of these enterprises is shown in Fig. 1. There are no reliable estimates of the total land drained by smaller enterprises or by farm drains. However, the area is large and probably at least one-third of cultivated lands in United States require group or farm drainage systems for most efficient use.

## HISTORICAL NOTES

Land drainage has had an important part in the development of American agriculture since colonial days. Elliott (1)* and McCrory(2) have provided many significant items of early historical development of drainage. The colony of South Carolina enacted a law providing for drainage of Cacaw Swamp in 1754 and the colony of New Jersey enacted a drainage law in 1772. Several states enacted drainage laws soon after the Revolutionary War. By 1870, several states had enacted drainage laws similar to those now in force.

John Johnson of Seneca County, New York installed the first drain tile on his farm in 1835. The hundred-year anniversary of this event was commemorated by the American Society of Agricultural Engineers. McCrory reported that by 1880, a total of 1,140 tile factories were in operation, chiefly in Indiana, Illinois, Ohio, Michigan, and Iowa.

In 1883, the Mason-Tazewell Drainage District in Illinois used steam-driven dipper dredges in commencing construction of its main drain 14½ miles long. This was the longest drain at the time and the first instance in which a large drainage job was handled successfully by such equipment. This equipment was said to have worked a revolution in drainage construction methods. Page and Schnable built the first drag-scraper excavator in 1903. By the beginning of the present century, steam-driven floating and land dredges had become established as the most economical ditch construction equipment. However, such equipment was crude by modern standards. Many of the early floating dredges were constructed at the upper end of a ditch job and abandoned on the completion of the job.

### Changes and Benefits of Drainage

The changes which resulted from drainage in the 50-year period may be realized by comparing the original conditions with those which exist now. To show conditions before drainage and what was accomplished by this work, the following quotations are taken from a passage in an interesting book entitled "Long's Expedition to the Source of St. Peter's River in 1823." The following describes conditions east of Fort Wayne, Indiana and south of Chicago:

"Near to this house we passed the state line which divides Ohio from Indiana. . . . The distance from this to Fort

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*Numbers in parentheses refer to the appended references.

Fig. 1 Land in drainage enterprises, 1950 census of drainage. Land shown is 102,688,331 acres of which 70 percent has been drained since 1905. Figure does not show enterprises less than 500 acres in size

Fig. 2 *(Left)* Corn field in Dakota County, Minn., in need of drainage • Fig. 3 *(Right)* Tile machine laying tile in Carroll County, Iowa. In the past 50 years tile machines have generally supplanted the laying of tile by hand

Wayne is 24 miles, without a settlement; the country is so wet that we scarcely saw an acre of land upon which a settlement could be made. We traveled for a couple of miles with our horses wading through water, sometimes to the girth. Having found a small patch of esculent-grass (which from its color is known here by the name of blue-grass), we attempted to stop and pasture our horses, but this we found impossible on account of the immense swarms of mosquitoes and horse flies.

"From Chicago to the place where we forded the Des Plaines, the country presents a low, flat and swampy prairie, very thickly covered with high grass, aquatic plants, and among others the wild rice. The latter occurs principally in the places which are still under water; its blades floating on the surface of the fluid like those of the young domestic plant. The whole of this tract is overflowed during the spring, and canoes pass in every direction across the prairie."

In traveling over the same route today, one would observe the urban development, especially around Chicago and Fort Wayne. The agricultural land which has been drained is among the most productive and most valuable of any in the Cornbelt. Substantial farm buildings and thriving villages are located in places which formerly were swamp or wet land. A similar change has occurred in about three-fourths of the drained areas shown in Fig. 1 in the past 50 years. However, the drainage problems are not all solved even in these areas. Public drains are in need of rehabilitation and maintenance and better farm drains are a general need as a sound base for sustained conservation farming.

Drainage was responsible for a great improvement in health conditions through reduction in mosquito breeding areas. Such improvements were noted especially in many midwestern and southern states. The improvement in health conditions has been one of the most important factors in many locations in public support of drainage works.

## Development of Drainage Enterprises

Most of the agricultural drainage in the United States has been accomplished through construction of outlet drains by drainage districts, county drains, or other drainage enterprises organized under state laws as the initial step. After providing an outlet, individual farmers could then construct farm drainage systems for their farms. This type of drainage has been effective in draining the upland prairies of the midwestern states and large areas in the coastal plains, lake plains, and along many stream and river bottoms. In some areas, particularly the Midwest, large draintile up to about 30 in in size are used to replace outlet ditches. Protection from overflow has been obtained where necessary by the construction of levees and dikes. In some areas pumping plants are required to lift drainage water because gravity drainage is not satisfactory. Table 1 shows the amount of the principal types of drainage works by states.

According to the 1940 Census which provided an analysis of individual enterprises, the average size of drainage enterprises was 2,200 acres after elimination of duplication such as subdistricts. This census showed that enterprises less than 500 acres amounted to nearly 7 percent of the total area; those of 500 to 5,000 acres to 35 percent; those of 5,000 to 50,000 acres to 40 percent; those from 50,000 to 500,000 acres, 15 percent and those over 500,000, the remaining 3 percent.

Each census since 1920 has had a separate volume on drainage of agricultural land. These volumes have provided reliable data on size and location of the organized enterprises and on the works of improvement. No similar data are available relative to farm drainage. Accomplishment reports of the U.S. Soil Conservation Service and the Agricultural Conservation Program Service have provided information by states on the annual amounts of drainage work accomplished under the agricultural programs.

## Federal and State Assistance on Drainage

In the past 50 years the trend has been toward providing public assistance for the construction and rehabilitation of drainage works. Most of the group drainage works were constructed by drainage districts, county drains and other types of public drainage enterprises. The funds were raised by special assessments on the lands directly benefited by improved drainage. Usually such enterprises could sell to investors bonds or notes payable over a period of 10 to 25 years. During the 1920's and 30's, due to depression and unforeseen difficulties in developing the lands, many enterprises defaulted on their outstanding indebtedness and generally neglected maintenance work. Very little maintenance work had been done during the depression years and many drains had decreased in capacity to ¼ or ⅓ the amount required for good drainage. The drainage conditions on many farms were so bad that farms were barely on a subsistence level. Many farms in drainage enterprises were sold for taxes or mortgages foreclosed. A small percent of the

TABLE 1. PRINCIPAL WORKS OF IMPROVEMENTS OF ORGANIZED DRAINAGE ENTERPRISES*

| State | Land in enterprises, 1950 | Increase since 1940 | Length of ditches, 1950 | Length of tile drains, 1950 | Length levees and dikes, 1950 | Area served by pumps |
|---|---|---|---|---|---|---|
| | Acres | Acres | Miles† | Miles† | Miles† | Acres |
| Alabama | 76,671 | + 48,626 | 108 | — | — | — |
| Arizona | 197,268 | − 101,365‡ | 101 | 9 | 25 | — |
| Arkansas | 4,701,095 | + 108,357 | 6,153 | 11 | 347 | 8,430 |
| California | 2,554,576 | − 112,618‡ | 6,125 | 337 | 1,538 | 694,023 |
| Colorado | 623,976 | + 155,654 | 984 | 366 | 1 | — |
| Florida | 6,083,676 | + 384,654 | 7,285 | 16 | 1,132 | 293,124 |
| Georgia | 96,259 | + 11,885 | 665 | 4 | 5 | — |
| Idaho | 436,171 | − 222,965‡ | 1,027 | 177 | 103 | 39,248 |
| Illinois | 5,370,825 | + 279,461 | 7,135 | 4,314 | 1,177 | 315,363 |
| Kansas | 356,988 | + 98,875 | 429 | 210 | 336 | — |
| Louisiana | 12,161,665 | +7,942,041 | 9,222 | 6 | 790 | 179,266 |
| Maryland | 323,815 | + 140,478 | 599 | — | — | — |
| Mississippi | 3,023,744 | + 133,126 | 4,716 | 34 | 191 | — |
| Missouri | 3,147,484 | + 60,421 | 5,222 | 170 | 704 | 67,217 |
| Montana | 289,189 | − 83,472‡ | 461 | 76 | 1 | — |
| Nebraska | 821,088 | − 95,093‡ | 1,574 | 27 | 231 | — |
| Nevada | 251,154 | + 97,781 | 447 | — | 23 | — |
| New Jersey | 11,206 | + 11,206 | 12 | 2 | — | — |
| New Mexico | 244,961 | − 60,924‡ | 625 | 309 | 181 | — |
| New York | 56,465 | + 56,465 | 31 | — | 2 | — |
| North Carolina | 1,128,509 | + 302,933 | 2,250 | — | 5 | — |
| Oregon | 418,858 | + 70,033 | 870 | 153 | 147 | 61,752 |
| South Carolina | 249,011 | + 44,645 | 588 | 6 | 1 | — |
| Tennessee | 615,838 | + 14,246 | 1,613 | — | 30 | — |
| Texas | 5,794,786 | +1,575,936 | 5,854 | 18 | 69 | 5,105 |
| Utah | 302,158 | + 100,100 | 297 | 1,624 | 5 | — |
| Virginia | 45,460 | + 29,746 | 106 | — | — | — |
| Washington | 431,613 | + 25,904 | 940 | 183 | 76 | 33,058 |
| Wisconsin | 514,700 | − 246,503‡ | 1,657 | 292 | 8 | — |
| Wyoming | 325,981 | + 13,319 | 648 | 262 | 7 | — |
| Delaware | 352,547 | − 42,467‡ | 1,484 | — | — | — |
| Indiana | 11,017,709 | + 895,757 | 22,206 | 10,803 | 159 | 5,412§ |
| Iowa | 6,734,863 | + 570,519 | 5,393 | 13,038 | 492 | 81,754§ |
| Kentucky | 959,892 | + 494,622 | 1,254 | 3 | — | — |
| Michigan | 10,194,439 | +1,216,053 | 20,163 | 3,375 | 14 | 800§ |
| Minnesota | 11,269,962 | + 279,553 | 16,214 | 9,973 | — | 1,315§ |
| North Dakota | 1,572,220 | + 196,179 | 1,034 | 10 | — | — |
| Ohio | 8,923,362 | +1,194,095 | 18,770 | 10,171 | 5 | — |
| Oklahoma | 300,884 | + 103,238 | 350 | — | — | — |
| South Dakota | 707,263 | + 30,791 | 841 | 336 | 7 | — |
| Total (40) States | 102,688,331 | +15,721,292 | 155,453 | 56,315 | 7,812 | |

*1950 Census of Agriculture except as noted.

†Obtained by adding amounts reported 1940 Census and amounts constructed during 1940 to 1949.

‡Decrease.

§1940 Census of Agriculture.

organized drainage enterprises, chiefly those having large areas of organic soils, were abandoned.

In 1935 the Reconstruction Finance Corporation was authorized to refinance drainage and irrigation districts in distress. This assistance enabled many drainage districts to continue operations during the depression years. Under the program RFC loaned some 40 million dollars to some 300 drainage enterprises in 26 states. On the average, they were the larger drainage districts and with minor exceptions have repaid these loans as due.

Drainage enterprises also received assistance through CCC camps, WPA, PWA, and other relief work during the 1930's. In 1935, the Bureau of Agricultural Engineering was assigned responsibility for 46 CCC camps to work on rehabilitation and reconstruction of drainage improvements organized under state drainage laws.

The effectiveness of such work is shown by work accomplished by the CCC drainage camps which reconstructed 6,444 miles of drainage ditches involving 64 million yards of dirt and rehabilitated 330 miles of tile drains. This work benefited 12 million acres of land.

Drainage work of camps and similar rehabilitation projects carried on under public works programs played an important part in conditioning the drained lands affected for the great expansion in agricultural production during and following the war years.

These federal and state programs of assistance during the 1930's helped many drainage enterprises avoid bankruptcy and to rehabilitate their physical works. This assistance was repaid many fold by increased food production during World War II. The flat lands requiring drainage are one of the primary sources of row crop production.

### Current Programs of Assistance

Several Federal agencies and a few states now provide assistance on farm or group drainage enterprises. At the present time the assistance on drainage is provided through several U.S. Department of Agriculture programs which have developed from the early programs. The early work of USDA included technical assistance on surveys of proposed drainage projects and research work. USDA engineers supervised work of CCC drainage camps and other public work types of programs.

The U.S. Soil Conservation Service through the soil conservation districts is providing technical assistance on drainage and other conservation practices to farmers in connection with their conservation farm plans. The on-site assistance furnished under this program has been a major factor in improving the drainage and efficiency of production of the farms benefited. The SCS also furnishes technical and other assistance on drainage work approved under the watershed program, Public Law 566, and determines the need, plans and inspects the drainage work established in connection with the Agricultural Conservation Program Service payments to farmers.

The ACP payments are made to farmers in many areas for installation of open farm drains, subsurface drains, land grading and land leveling for drainage. The Agricultural Research Service is carrying out a broad program of drainage research. Credit agencies are authorized to provide credit to drainage enterprises and individuals for drainage improvements.

The Corps of Engineers of the U.S. Army has responsibility for construction of major drains. They have authority for surveys, and construction or improvement of many channels classified as drainage outlets. Usually these channels are larger than those planned by the SCS under its programs and serve as outlets for drains constructed by drainage enterprises. The levee and flood control works constructed by the Corps of Engineers has made it possible to drain and reclaim large areas along many large rivers.

The Bureau of Reclamation is planning and constructing drainage systems for many of its reclamation projects for which it is responsible.

Several states have provided assistance to drainage and flood control enterprises from state funds. Louisiana, in 1941, started a statewide drainage program which operates in the following manner. On request of the governing body of the parish (county) surveys are made and a proposed plan prepared by the state department of public works. An election is held in each parish to approve the plans and bond issue for the parish's share of the work including an annual tax for maintenance. Under the program the parish takes over the indebtedness, works of improvement and maintenance of the existing drainage districts. Some typical jobs have been on a basis of the state contributing about 40

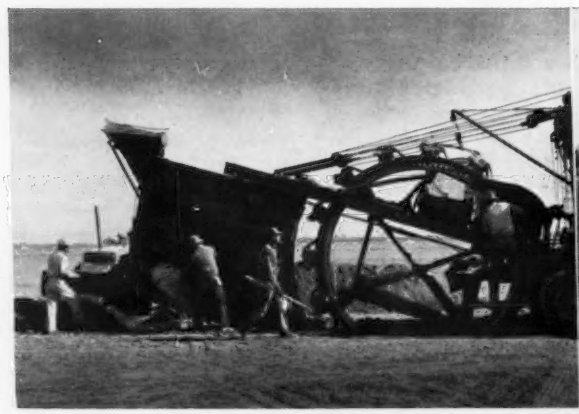

Fig. 4 *(Left)* Tile machine for deep tiling of irrigated land in Imperial Valley, Calif. The shoe behind the wheel prevents the trench from caving. The hopper at top of shoe feeds gravel for filter material around tile. Bulldozer at left, behind shoe is to backfill trench • Fig. 5 *(Right)* Cleaning a field lateral ditch in Louisiana called a split ditch. Sloping bucket shapes ditch in one pass

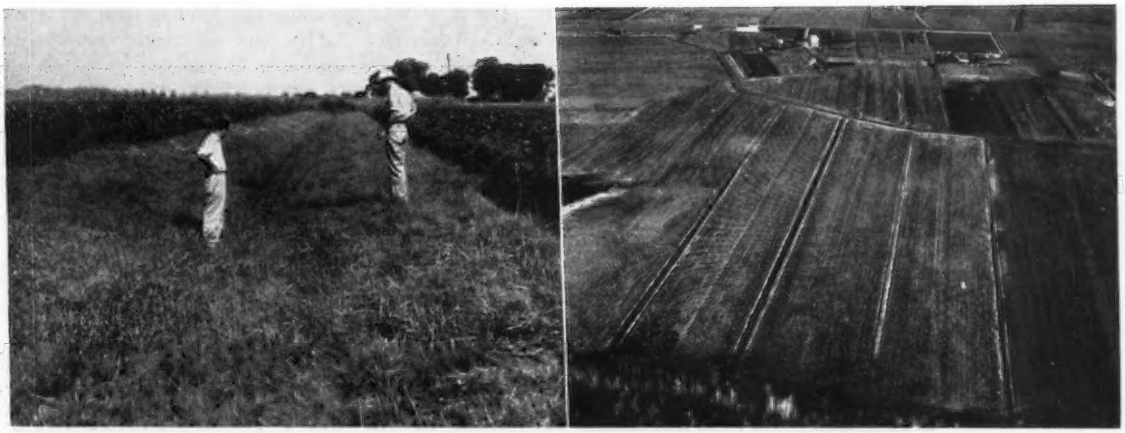

Fig. 6 *(Left)* Field lateral in Louisiana built to 3:1 side slopes and maintained by mowing • Fig. 7 *(Right)* Aerial view of parallel ditch system in Sussex County, Del.

percent of the construction costs and parish about 60 percent. The Corps of Engineers, U.S. Army, has constructed numerous main drains from federal funds to provide major outlets required under the program. Soil conservation districts have made a contribution to the program by providing technical assistance to small groups of farmers for construction of additional group drains to provide outlets for farm drains. Also, farmers have carried on intensified work on farm drains under the conservation programs of the soil conservation districts. Under this program substantial progress has been made toward completion of a well planned drainage system on a watershed basis. Levees and floodways are necessary to protect a large proportion of the drained lands of the state from the Mississippi or other rivers.

Other states which have provided financial assistance include Delaware which has set up a state department with responsibility for cooperation on tax supported drainage work. North Dakota has provided direct grants in aid from state funds for drainage work on county drains. This work also has been carried out in cooperation with the soil conservation districts and the Soil Conservation Service.

## Scientific Advances in Drainage

In the past 50 years great advances have been made in the scientific aspects of drainage through research, improved procedures in design, and improved equipment and methods of construction. Advances have also been made through conservation treatment of land in the watershed, in controlled drainage, in related fields of soil and water conservation, and land use and flood control. In this paper we can, of course, only touch briefly on some of these important developments and must necessarily omit many of equal significance. Current literature and the publications of federal and state agencies have generally covered the results of scientific research.

AGRICULTURAL ENGINEERING, has published a large number and variety of papers covering the current advances in drainage. The articles on drainage in this Journal have recorded many of the scientific advances as they have developed.

Two bibliographies on land drainage furnish a guide to the literature on drainage. A mimeograph bibliography on land drainage, (245 pages) published by the former Bureau of Agricultural Engineering in 1936 is available in some libraries. The USDA library last year published a bibliography (3) covering selected annotated references to drainage literature published between 1936 and 1955.

Several text books cover the scientific aspects of drainage. Members of ASAE have been authors of recent texts which cover the field (4, 5).

## Some Conservation Aspects

Progress in the conservation aspects of drainage is one of the most significant milestones of progress in recent years. Many of the early drainage enterprises were of a promotional nature or were only partly developed. In some districts outlet ditches were dug, timber was cut and the cutover land was sold to settlers, many of whom did not have the resources or the knowledge to carry on and create productive farms from the bare land. In many cases farm drains were not constructed and the outlets were not effective. Now it is recognized that a complete drainage system must be provided to remove excess surface water and control the groundwater through field drains, laterals and mains to the outlet.

Soil surveys furnish a basic guide to land capability interpretation in developing land through drainage. Some of the early drainage projects failed because soils information was not obtained and interpreted prior to draining. For example, large areas of peat lands in northern Minnesota were drained and it was not until many millions of dollars had been spent on outlet drains that it was realized that the land was not capable of profitable development. Extensive failures of drainage enterprises occurred there and also in some of the southeastern states due to many causes. While these failures have been serious, their extent should not be overestimated. Over 95 percent of all the land that has been drained is capable of sustained agricultural use and has remained in productive use.

On many drained lands the application of necessary soil amendments, including minor elements and crop rotations, are necessary to successful farming and soil management in drainage enterprises. Many fields were originaily drained with subsurface drains spaced at the maximum distance then thought desirable. Drainage was adequate for many years. Continuous cultivation of row crops such as corn, soybeans and cotton and other cultivated crops suited to the locality

in many cases exhausted the humus material and fertility of the soil and broke down the soil structure. These changes made the soil more difficult to drain. Drains had to be spaced closer together and legumes and grass crops inducted into a rotation. It has become necessary to add lime, fertilizers, and other soil amendments to maintain fertility for efficient crop production. Progressive farmers of drained lands now adopt soil conservation plans as a basic principle of farming.

### Design of Drainage Systems

One of the most significant advances in drainage in the past half century is the development of concepts of design of complete and effective drainage systems to serve large tracts of land, with due regard to soil characteristics and degree of protection justified. This concept has several important implications which need explanation. Under this concept a soil survey is made to determine its capability for agricultural use. Much of the remaining wet land in this country is more suitable under present conditions for wildlife or forest than for cultivated crops. Some areas are well suited for intensive truck cropping. Engineering surveys are made to determine the information needed for design and construction. Some areas require dikes or levees for protection against overflow and some require pumping because gravity drainage is not feasible. Many soils require subsurface drainage, land grading, shaping or leveling, as well as effective surface drainage systems.

Based on surveys and investigations, a drainage system is planned to provide the degree of protection as required by the planned land use. In this way the system is planned in the same way as a building or machine to serve specific needs with all the parts bearing a proper relation to the whole. Economy in construction is achieved and the influence of the system on the watershed as a whole is considered. A balanced design is provided so that areas downstream will not receive excessive damage from areas upstream.

### Outlet Drains

Progress has been made in 50 years in establishing the required capacities, hydraulic factors and other criteria for the design of open ditches.

The practice of spreading and leveling spoil banks for ditches on cultivated land has come into common use whereas this practice was little used even 25 years ago.

Auxiliary structures are provided to admit water to ditches to prevent rapid erosion. Such structures are designed in accordance with sound engineering principles.

### Drainage Coefficients

The economical design of drainage improvements requires reliable estimates of the runoff. The USDA drainage investigations made extensive investigations prior to 1938 in the following states: Iowa, Missouri, Louisiana, Tennessee, Mississippi, Arkansas, Florida, Illinois, Indiana and Ohio. These investigations furnished basic data for preparing drainage coefficients and runoff curves for the design of drainage systems and structures. The term "drainage coefficient" means the recommended initial design capacity of a drain. The initial capacity of an open drain is considerably higher than the average capacity over its life. A normal situation is for an open drain to lose ¼ to ⅓ of its capacity in 10 to 15 years. A normal period between initial construction and a major cleanout or rehabilitation is 12 to 20 years. The drainage coefficients should be high enough to provide good drainage protection over the life of the drain, taking into account the rate of sedimentation.

Drainage coefficients may be divided into four classes:

*(a)* A uniform rate of runoff applicable to the entire watershed area.

*(b)* A uniform rate of runoff applicable to a maximum size watershed area and lower rates as the watershed area increases.

*(c)* Drainage runoff curve based on measured flows from comparable drained areas.

*(d)* Drainage coefficient curves to provide degree of protection required for different levels of land use, modified for the type of contributing area and to provide good drainage over the life of the drain.

*Class 1:* Coefficients have been used chiefly for subsurface drains and drainage of small areas. For example, open farm drains are often designed on a uniform rate of 1½ to

Fig. 8 *(Left)* Aerial view of Pocomoke River drainage ditch outlet constructed with SCS assistance. Ditch designed to provide outlet to cultivated land and swamp land adjoining ditch to remain in woods • Fig. 9 *(Right)* Battery of floodways and drainage ditches of Little River Drainage District, Dunklin County, Mo., constructed about 40 years ago to furnish outlet for over 400,000 acres. Ditches are designed to operate at different elevations

3 in runoff per 24 hours from the contributing watershed area. Occasionally some larger areas were designed on this basis (6).

*Class 2:* Coefficients were used widely in the design of drainage systems during the period 1905 to 1915. Elliot, in his text on Engineering for Land Drainage, (1) recommended this type of coefficient in his first edition of 1903. Many of the early drainage systems designed by drainage engineers of the USDA Office of Experiment Stations were designed, using this class of coefficient. For example, the outlet ditch of Boggy Swamp, Hampton and Jasper Counties, S. Car., was designed for a runoff of ¾-in depth from its watershed for areas over 20,000 acres and 1-in depth for areas under 20,000 acres (7).

*Class 3:* This class of drainage runoff curves began to be developed about 1907 and came into more general use in design until about 1937. These curves represent much of the basic data on which our present curves are based. An early example of the use of such curves was in the St. Francis Valley Project in northeastern Arkansas, reported in 1909 by Arthur E. Morgan and O. G. Baxter. The runoff from the flat areas was estimated by a formula which gave results lower than coefficients now in use.

*Class 4:* The fourth class of drainage coefficients are the drainage curves now in use. They were developed beginning about 1937 and have been revised as data and experience in their use warranted. The basic data available on the runoff from similar areas were considered in developing the curves. They are intended to provide good drainage over the life of the drain. It is recognized that an open drain will ordinarily lose a substantial part of its capacity in 10 to 15 years. Different curves are recommended, depending on the intensity of land use. Curves for hill areas provide for higher rates of discharge than for flat lands. Procedures for using such curves to obtain a specified degree of protection and a balanced design have been included in the National Engineering Handbook of the Soil Conservation Service.

The USDA drainage investigations conducted studies of the hydraulic characteristics of drainage channels. A formula known as the Elliot formula was generally used for computing flow of water in drainage ditches until about 1912. This gave results comparable to using a value of $n$ of about 0.0225 in Kutter's formula. The U.S. Department of Agriculture made investigations and published a department bulletin(8), covering the basic data now in use for determining the value of $n$ in Manning's or Kutter's formulas. Ramser also conducted a study of factors affecting erosion and silting of dredged drainage ditches(9). Results of studies of bridge piers and pile trestles as channel obstructions were also published.

The Soil Conservation Service conducted experiments on flow in channels protected by vegetated linings supervised by W. O. Ree and V. J. Palmer(10).

### Surface Drainage Systems

Formerly the surface drainage of fields was one of the most neglected phases of drainage. Bedding was practiced in some areas but frequently resulted in little benefit. Work on many early drainage systems stopped after the outlet drains were built and necessary farm drains were not built. A highly significant development of the past 20 years is the widespread establishment of planned surface drainage systems on farms. The principle involved is to avoid standing water and to provide farm ditches which will collect water from rows or fields and keep it moving. The capacities of farm ditches must be large enough to prevent damage.

The principal systems of surface drainage include: bedding, random, cross slope and parallel. Criteria have been established for depth and spacing of ditches and maximum row length for best results. Land forming, grading, or leveling is a planned part of many surface drainage systems. Many open ditch systems are designed to provide water control.

Many farm drainage ditches are designed for easy maintenance and so farm equipment may operate with ease over the flat side slopes. A "*V*" or single ditch is used where placement of spoil will not interfere with drainage. The "*W*" ditch with two separate ditches and spoil placed between permits maintenance without the spoil blocking field drainage.

### Land Forming, Smoothing and Leveling for Drainage

One of the newest of drainage practices is land forming which includes grading, leveling or smoothing for drainage as it is called in various locations. Many of the so-called "level" fields have some slope but frequently have a considerable portion of their areas in depressions which impound water after rains, possibly one or two inches deep. On many fields of this type the crops show distress and the soils are puddled in the depressions. About 10 years ago several soil conservation districts encouraged demonstrations of land grading and smoothing for drainage. Research on grading for sugarcane in Louisiana indicate it has been highly successful there(11). This practice has been adopted by many farmers. It has also had wide acceptance by the technical people working in drainage.

### Development of Excavating and Clearing Equipment

In the past 50 years the dragline excavators driven by internal combustion engines have almost entirely supplanted floating dredges and steamdriven equipment for construction of large drainage ditches. The dragline excavator has become so readily available that it has become an efficient tool for periodic maintenance as well as for construction.

The construction of the Pocomoke River (1940-44) drainage ditch under supervision of the Soil Conservation Service in Maryland and other large drainage jobs proved that the ordinary dragline operating on mats could be used efficiently under the most difficult swamp conditions on work that previously had been considered most suitable for floating dredges.

Tractors with land-clearing blades minimize the need for hand labor in drainage construction and in land clearing. The development of the large crawler tractors and accessory equipment has contributed much towards the recent progress in drainage construction and land clearing.

The crawler tractor has been widely used for leveling spoil banks. The leveling of spoil banks was a practice which was introduced in numerous locations by the CCC drainage camps in 1935 and has become a common drainage practice since then. Leveling of spoil banks makes this area available for agricultural use and eliminates a source of weeds and brush, and facilitates maintenance work.

The tractor has encouraged the use of *V* and *W*-shaped and wide flat bottom ditches for open drainage systems. Large carry-all and similar tractor equipment has been used

widely for the construction of levees and dikes and for land leveling.

### Subsurface Drainage

There have been many advances in subsurface drainage practices during the past 50 years. To give credit where due, the early workers had perfected excellent procedures of laying tile by hand by the beginning of the present century. There appeared to be widespread appreciation of the benefits of subsurface drainage in many areas as revealed by the literature of that period. Many of the drainage systems then installed have remained effective for 30 to 50 years.

Clay pipe continues to be used widely and has improved in quality. Concrete draintile has come into common use during the 50-year period. Bituminized fiber pipe has been used in some locations. Corrugated metal pipe has come into use for outlets and for special conditions such as in quicksands or at road crossings. Trade associations of manufacturers have played an important part in the development of higher standards in the industry and in the improvement in quality.

Great progress has been made in the quality of materials for draintile. The American Society for Testing Materials has prepared specifications covering clay and concrete clay tile which are generally used(12). These specifications were first issued in 1914 and have been revised and improved several times.

The American Society of Agricultural Engineers has adopted a tentative ASAE Recommendation: "Design and Construction of Tile Drains in Humid Areas," published in the Agricultural Engineers Yearbook. This covers such subjects as drainage coefficients, capacity, minimum size, minimum depth, tile loading, tile outlet protection, accessory structures and construction. Much research and experience has gone into the preparation of these recommendations, which are widely used.

Much progress has been made in research to establish the principles of subsurface drainage and the movement of water through soils. Federal agencies and colleges have conducted work on this subject and Iowa State College has done work of particular significance in this field(13).

Principles of design of filter materials have been established so that gravel mixes may be designed and can be laid to surround the tile and prevent base material from entering. The work of the Army engineers at the Vicksburg laboratory and the U.S. Bureau of Reclamation have been important in this field.

### Hydraulic Factors of Drain Tile and Pipe

Much progress has been made in a half century in establishing the hydraulic factors of flow of water in drain tile and pipe on losses of head through culverts. Research work needs to be continued and expanded to determine hydraulic factors in connection with drain tile.

The capacities of clay, concrete and corrugated metal pipe has been studied by laboratory methods and formulas covering flow in such pipe are in common use.

The St. Anthony Falls Laboratory of the University of Minnesota is conducting studies of energy losses at drain-tile junctions, a study of which will be of assistance in designing subsurface drainage systems. An article covering progress on this project was published in a recent issue of AGRICULTURAL ENGINEERING(14).

### Construction of Tile Drains

During the half century the installation of drain tile has changed from a hand job to a machine job. Tile trenching machines of the wheel type or ladder type are used almost exclusively for installation of shallow tile. Backhoe or draglines are used for installation of deep tile. "Shoes" attached behind trenchers and "shields" pulled behind draglines or backhoes prevent the sides of trenches from caving and permit laying under difficult conditions. On some trenching machines tile is fed to the bottom of the trench in a chute. Some trenching machines have been equipped to lay a gravel filter by feeding gravel from bins on the trenchers to the bottom of the trench. Some trenchers have been equipped to backfill in the same operation. However, laying the tile to provide proper joint clearance and blinding are generally the skilled hand labor job of the tiler.

### Mole Drainage

Mole drainage is a drainage practice which is not used widely outside a few locations. It is used as a common practice in the organic soils of Florida which are free of stumps and require this kind of drainage.

### Pumping for Drainage

One of the most significant and far reaching advances in drainage techniques in the present century has come about through the development and use of efficient equipment for drainage pumping and water control. A half century ago pumping was practiced on an extensive scale in Holland, but only a few steam-driven drainage pumping plants were in operation in this country.

In a half century the United States has drained more land by pumps than the area drained in the Netherlands. The 1950 census on drainage showed that in 30 drainage district states, 378 drainage enterprises reported the use of pumps which served 1,696,586 acres. That does not include pumping plants in states listed as county-drain states nor data covering irrigation enterprises which had installed drainage pumping plants. The area served by pumps in 1950 in California was 696,023 acres; in Illinois 315,363; Florida 293,124; Louisiana 172,266; and Missouri 67,217 acres. In 1940 Iowa, a county-drain state, reported 81,754 acres served by pumps.

Many of these projects embraced 3,000 to 20,000 acres of river bottoms, lake and coastal plains, peat or irrigated lands. The modern trend is to provide for water control and irrigation where drainage pumping is used.

In Florida the Central and Southern Flood Control Project is outstanding for its large capacity pumping plants. Pump station 5-A contains 6 propeller-type 116-in pumps, each having a rated capacity of 360,000 gpm. These are believed to have the highest capacity of any pumps in the world even though the diameter of their impellers is 106 in compared with the 144-in pumps which drain the city of New Orleans.

Progress in the development of small drainage pumping plants has been especially important in the past decade. This is due to the availability of electricity on the farms and improved efficiency of tractors, internal combustion engines, and small pumps. Many farmers can drain and utilize wet fields by use of pumps which could not otherwise be farmed.

Research work on drainage pumping has included studies to determine the costs of pumping(15) and the design and operation of drainage pumping plants(16).

Drainage pumping is of particular significance in the future development of agricultural land resources of the county when additional lands are needed. There are large areas of tidal marshes which can be developed through diking, pumping and water control works.

### Levees and Dikes

Levees and dikes are required to prevent overflow of many drainage enterprises. Many such enterprises construct levees and dikes as an integral part of their works of improvement.

During the past 50 years the Corps of Engineers, U.S. Army, has constructed dikes and levees along many navigable rivers. This has made it possible to drain millions of acres of bottom land along the Mississippi, Missouri, Red River, Arkansas, Illinois, and other major rivers. Many of the early levees and dikes which were constructed by local drainage and levee districts failed during floods and it became essential for the Federal Government to provide aid in the protection of cities, towns, as well as the agricultural lands developed in the river bottoms.

The prediction of maximum flood flows has been developed as a major activity in the fiield of hydrology. Major levees and dikes are designed, using the scientific principles which have been developed for constructing such works. Many cities are secure against flooding, from the greatest flood likely to occur, through protective levees and dikes. Effective protection for large areas and the practice of building safe levees and dikes has developed in this country almost entirely in the past 50 years.

### Drainage of Organic Soils

The drainage of organic soils during the past 50 years has reclaimed some of the nation's most productive land for truck crops in Florida and other locations. In some areas the drainage has not been successful due to high acidity, susceptibilty to frost or other causes. Rates of subsidence of organic soils have been determined so that the life of the development may be predicted. These problems in the use of such soils has stimulated the development of special drainage practices for improving lands described in references listed in the USDA bibliography.

### Controlled Drainage

Controlled drainage is an important practice in some locations which has come into use in the 50-year period. One system of controlled drainage is to install check dams with stop logs which may be raised or lowered to control the water level in open ditches. Similar control has been obtained by gates in drain tile or by regulation of pumping in projects drained by pumps. The practice has been particularly successful in drainage of organic soils which require full capacity of drains during part of the year and a water table not over 24 in deep during the growing season. During the dormant season a high water table is an important conservation measure on organic soils since oxidation and rates of subsidence are reduced. The practice has been used in conjunction with subirrigation in some areas where an irrigation water supply could be provided.

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## Recalls National Tractor Demonstrations

THE following excerpt from a letter, written by G. B. Gunlogson, life member of ASAE, pays homage to a man who played an important role in the early development and progress of power farming. This man is A. E. Hildebrand, now editor of Hildy's Ford Blue Book. The unique service rendered by Mr. Hildebrand to the farm equipment industry through his connection with the National Tractor Demonstrations has been regarded by many as a big factor in advancing the development of farm tractors and power equipment.

A. E. HILDEBRAND

. . . For some years A. E. Hildebrand was engaged in the development and promotion of a type of tractor chassis embodying an automobile power plant. This device did not get very far but it was one of the many evolutionary steps in the development of the tractor. Mr. Hildebrand rendered his great contribution to the industry in connection with the National Tractor Demonstrations. He, more than anyone else, was the sparkplug and the master of ceremonies at the early regional and national demonstrations.

These demonstrations were unique in many respects. No other industry in America has ever staged any events, on a comparable scale that were so constructive and far reaching in their effects.

In 1916 these demonstrations were held in eight different states, starting at Dallas, Texas, and ending at Madison, Wisconsin, two months later. Farmers came from nearly every state in the union to learn, and to look. Hundreds of thousands of farmers saw tractors for the first time at a close range. They came to see if tractors would do more than just plow, to compare one make or model with another, to compare the tractor with horses and to discuss tractors

*(Continued on page 460)*

# Irrigation in the Far West

**Harry F. Blaney and Martin R. Huberty**
Member ASAE Member ASAE

IN THE development of our country, the term Far West has not always referred to the same area. While Philadelphia was once considered the far west, the term now normally implies the area west of the Continental Divide. With the exception of reporting irrigated areas on a state basis this article will relate to the area west of the Rocky Mountains.

The west is a region of great extremes in elevation from nearly 15000 ft to below sea level, in climate from the cool, moist northwest to the dry, hot deserts of the southwest, and in population, from densely settled coastal areas to the sparsely populated intermountain sections.

It is not illogical that irrigation has long been practiced by the peoples of the southwest for here precipitation was lacking or too poorly distributed for good crop production. The aborigines practiced irrigation in Los Animas Valley in western Colorado, in the Salt River Valley of Arizona, and in other parts of this vast arid country. The sites for the Spanish missions in Arizona, California and New Mexico were selected largely on the basis of an adequate water supply for irrigation. The San Diego Mission established in 1769 included an irrigation system. Early settlers throughout the west practiced irrigation in varying degrees. Fremont, in his treks to the west in 1843, noted the irrigated pastures of John Thatcher at Pueblo, Colorado, and of Lassen's farming activities on the banks of Deer Creek in northern Sacramento Valley, California. The success of the early settlements in Utah in 1847 was in large measure dependent upon the rapid expansion of irrigation by community development. By the beginning of the twentieth century, irrigation had become well established in the west.

### Irrigation Census

The earliest federal census of irrigation was that of 1889 and successive censuses have been taken every decade since. Summary figures of irrigated acreage for the nine western states are reported in Table 1.

Paper prepared expressly for the Golden Anniversary issue of AGRICULTURAL ENGINEERING on twentieth century development.

The authors—HARRY F. BLANEY and MARTIN R. HUBERTY—are, respectively, principal irrigation engineer, (SWCRD, ARS), USDA, Los Angeles, Calif., and professor of irrigation and engineering, University of California, Los Angeles.

A review of Table 1 shows that at the beginning of the century Arizona had less than 200,000 acres under irrigation, 19 percent of what was reported in 1949. California and Washington had a 4½ fold increase during the 50 year period while Oregon and New Mexico increased 3½ times. On the other hand, Utah's acreage did not double, and Nevada's 1900 acreage was 69 percent of that of 1949. Some very substantial increases in irrigated acreages have taken place since 1950, much of it through the private development of ground water supplies. It should be kept in mind that some of the earliest irrigation systems were very crude and the water supplies were available during relatively short periods.

The cost of irrigation development has increased considerably since the pioneer days. In later years, however, new sources of irrigation water supplies have become limited while the area of irrigable land is still extensive. Larger, longer, and more costly diversion, storage, and conveyance structures have been needed. The federal irrigation censuses of 1920 and 1950 indicate that the average capital investment per acre of irrigated land increased from $39 in 1920 to $96 in 1950 in the nine far western states shown in Table 2.

### Irrigation Enterprises

The history of enterprises concerned with the development of irrigation is an interesting one. The earliest irrigation systems were, in the main, those that were easiest to develop. Often it meant the simple diversion of water from stream to adjacent land. Usually these systems did not provide an adequate water supply during the latter part of the irrigation season.

Over much of the west early irrigation development was largely a private matter. In time, however, farmers began to organize into groups for the purpose of developing water systems. This movement led to the formation of a succession of enterprises, including simple partnership, mutual water companies, commercial water companies, and irrigation districts. Much of the rapid expansion in irrigated acreage that took place during the early part of the century occurred under the irrigation district type of organization, a public

Fig. 1 Shasta Dam on Sacramento River, California (Constructed by the U.S. Bureau of Reclamation)

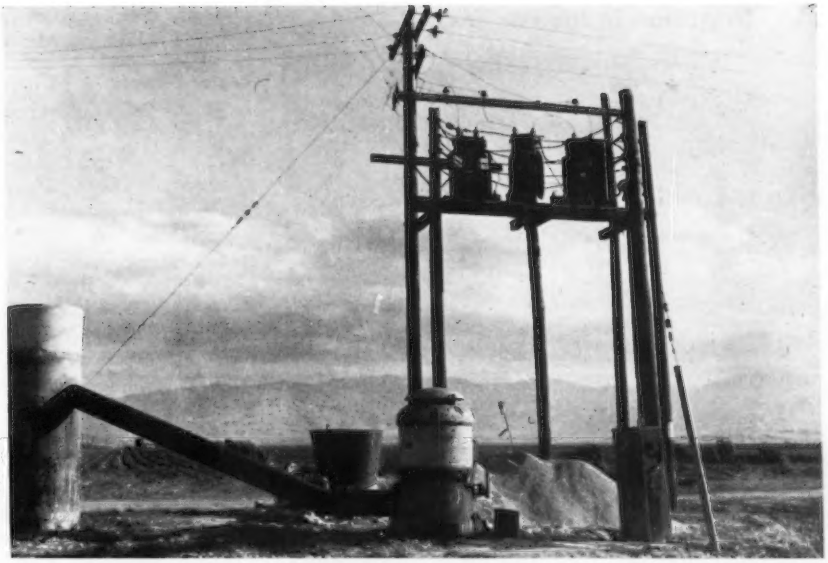

Fig. 2 Pumping for irrigation

corporation organized under state laws empowering it to issue bonds and levy and collect taxes.

In some areas extensive water systems had been developed to deliver water for hydraulic mining. When the mines had been worked out, or the practice of hydraulic mining had been banned by legislation, their owners attempted to sell the water for irrigation. Other commercial water companies were formed, many in conjunction with land development schemes. Selling water to farmers, however, has not been generally profitable, so this form of irrigation enterprise has largely disappeared from the scene.

The federal government has tried to encourage irrigation through the passage of the Carey Act in 1894, but without much success. But, with the passage of the Reclamation Act in 1902, the national government became an active participant in irrigation development. In recent years, the Bureau of Reclamation has been concerned primarily with basin system development, the Central Valley Project in California (Fig. 1), the Columbia River Basin Project and the Upper Colorado River Storage Project being good examples.

The 1950 United States Census of Agriculture classified irrigation enterprises under the following types: *(a)* single-farm, *(b)* mutual or cooperative, *(c)* district, *(d)* commercial, *(e)* United States Bureau of Reclamation, *(f)* United States Bureau of Indian Affairs, *(g)* state, and *(h)* city.

Aside from the federal agencies, the principal types of irrigation enterprise organizations (or projects) are mutual or cooperative irrigation companies, districts (irrigation and other types of authorized districts), and commercial irrigation companies.

While the size and complexity of the surface water supply have undergone revolutionary changes during the past fifty years, the development of ground water resources has been every bit as marked. At the turn of the century, an engine driven centrifugal pump, often in a pit, represented an up-to-date well pumping unit, while now electrically powered deep well pumps delivering water from depths in excess of 500 feet are not uncommon (Fig. 2). The recharge of ground water basins during periods of high runoff for use during periods of deficiency represents an important part of water management. The storage capacity of some of the ground water basins, within the normal pumping range, is tremendous; some exceeding by several fold the capacity of the largest surface reservoirs.

## Water Quality

The public generally is aware of the need for making quantitative determinations of the water volume, but seems less concerned about the dangers of degrading water quality. A characteristic of western streams is the general lowering in water quality progressively downstream. This is well illus-

TABLE 1. IRRIGATED ACREAGES OF THE ELEVEN WESTERN STATES DURING THE PERIOD 1889-1949*

| State | Area square miles | Irrigated acreage by census years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1889 | 1899 | 1909 | 1919 | 1929 | 1939 | 1949 |
| Arizona | 113,580 | 65,821 | 185,396 | 320,051 | 467,565 | 575,590 | 727,069 | 1,053,574 |
| California | 156,803 | 1,004,233 | 1,445,872 | 2,664,104 | 4,219,040 | 4,746,632 | 5,524,910 | 7,394,871 |
| Colorado | 103,967 | 890,735 | 1,611,271 | 2,792,032 | 3,348,385 | 3,393,619 | 3,848,700 | 3,331,381 |
| Idaho | 82,808 | 217,005 | 602,568 | 1,430,848 | 2,488,806 | 2,181,250 | 3,187,859 | 2,243,652 |
| Nevada | 109,802 | 224,403 | 504,168 | 701,833 | 561,447 | 486,648 | 824,585 | 731,708 |
| New Mexico | 121,511 | 91,745 | 203,893 | 461,718 | 538,377 | 527,033 | 559,162 | 711,935 |
| Oregon | 96,349 | 177,944 | 388,310 | 686,129 | 986,162 | 898,713 | 1,154,146 | 1,351,578 |
| Utah | 82,346 | 263,473 | 629,293 | 999,410 | 1,371,651 | 1,324,125 | 1,499,110 | 1,234,938 |
| Washington | 66,836 | 48,799 | 126,307 | 334,378 | 529,899 | 499,283 | 799,677 | 658,190 |
| Total | 934,002 | 2,984,158 | 5,697,078 | 10,390,503 | 14,511,332 | 14,632,893 | 18,125,218 | 18,711,827 |

*"United States Census of Irrigation of Agricultural Lands," U.S. Dept. of Commerce, Bureau of Census.

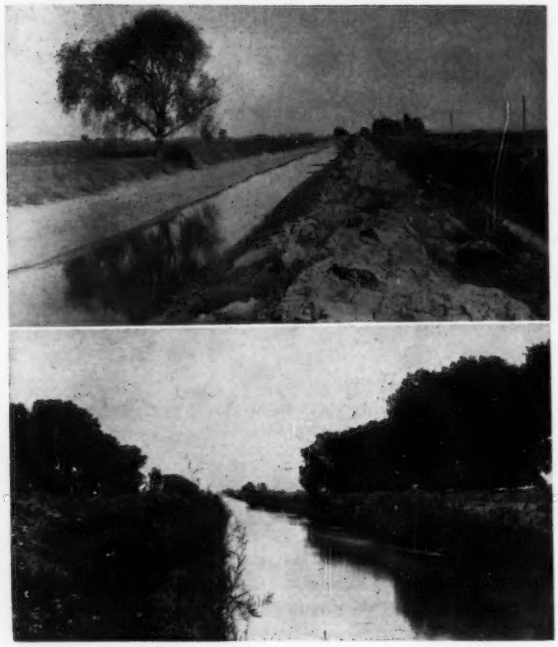

Fig. 3 *(Top)* Unlined irrigation canal and drainage ditch in Imperial Valley, Calif. • Fig. 4 *(Bottom)* Irrigation canal, Imperial Valley, Calif.

trated in the case of the Santa Ana River in California. The stream originates in high granitic mountains, passes through a highly developed agricultural area and discharges into the Pacific Ocean. Water is diverted and the underlying basins are heavily pumped. The resulting effect is a decrease in volume and an increase in salt concentration with increases in the sodium and boron content. It is therefore necessary when irrigating in arid and semiarid climates to add sufficient water to leach salts from the root zone. This practice often produces a drainage problem.

### Drainage

Even though drainage is a necessary corollary of irrigation, the West has not given it the attention it deserves. The census figures show that there has been no marked increase in the area drained in the nine western states during the period 1930 to 1950, even though during the same period the irrigated acreage expanded some 4 million acres. An estimated 8 million acres of land in the West needs drainage.

The nature of soils and the extent of concentration of harmful mineral elements influence the choice and design of the drainage system. Areas requiring prolonged leaching call for the installation of tile drains. The ability of the separate layers of soil to transmit water largely determine both the type of systems that should be installed and its design. Open drains at 1-mile intervals may be adequate for draining areas of extremely porous subsoils, while heavier soil might require tile lines spaced not more than 100 ft apart (Fig. 3).

### Water Supply

A characteristic of much of the southwest is that potential agricultural lands exceed the water supply. In the west there is also a great geographic disparity in water supply. Much of the northwestern states of Washington and Oregon lies within the Columbia River basin. This stream, with an average annual runoff of about 180,000,000 acre-feet, is the second largest in the United States. Its waters are also of high quality for irrigation. The Colorado River basin on the other hand, drains parts of seven states and represents about 1/12 of the United States, yet has a total runoff of approximately 1/10 that of the Columbia. Its waters in the lower reaches contain far more soluble salts than does the Columbia River.

Much of Utah and most of Nevada lies within the high basin plains and mountains of the Great Basin, and, therefore, have no drainage to the ocean. No major stream is to be found here. Future irrigation development in Nevada will probably involve ground-water development, and some diversions from the Lower Colorado River, while Utah will undoubtedly receive additional water from outside sources.

California, which has approximately 40 percent of the irrigated area of the west, has a long time mean annual runoff of about 70 million acre-feet. The greatest body of irrigated land is to be found in the great Central Valley, of which at least half is irrigated with ground water.

### Development of Large Irrigation Projects

The development of a large irrigation project is a substantial undertaking that requires considerable investigation and planning. Three basic elements, land, water, and people, have to be considered. Legal, political, economic, social, and interregional problems are involved. It requires the combined skills of engineers, soil scientists, economists and other professions.

A completed irrigation project has generally encountered the following periods of activity: *(a)* preliminary investigations, financing, and organization; *(b)* construction of works; and *(c)* operation and maintenance of the system.

As previously indicated, the development of large irrigation projects is done by irrigation or water districts organized under state laws, or by the United States Bureau of Reclamation. Usually these projects require the construction of

TABLE 2 CAPITAL INVESTMENT IN IRRIGATION ENTERPRISES IN FAR WEST STATES 1920, 1940 AND 1950*

| State | Total capital investment | | | Average capital investment per acre of irrigated land | | |
|---|---|---|---|---|---|---|
| | 1920 | 1940 | 1950 | 1920 | 1940 | 1950 |
| | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Arizona | 33,498,094 | 83,526,608 | 137,575,193 | 72 | 128 | 141 |
| California | 194,886,388 | 318,889,218 | 640,474,185 | 46 | 63 | 97 |
| Colorado | 88,302,442 | 106,849,343 | 163,295,813 | 26 | 33 | 55 |
| Idaho | 91,501,009 | 102,585,798 | 129,973,554 | 37 | 45 | 60 |
| Nevada | 14,754,280 | 16,906,790 | 20,181,476 | 26 | 23 | 28 |
| New Mexico | 18,210,412 | 32,735,997 | 61,137,909 | 34 | 59 | 88 |
| Oregon | 28,929,151 | 50,961,251 | 74,360,981 | 29 | 49 | 56 |
| Utah | 32,037,351 | 41,896,532 | 56,539,436 | 23 | 36 | 48 |
| Washington | 29,299,011 | 56,415,196 | 178,289,988 | 55 | 92 | 288 |
| Total | 531,418,138 | 810,766,733 | 1,461,828,535 | | | |
| Average | 59,046,460 | 90,085,193 | 162,415,393 | 39 | 58 | 96 |

*Based on "United States Census of Irrigation of Agricultural Lands," U.S. Dept. of Commerce, Bureau of Census.

Fig. 5 Planer for leveling land

dams, storage reservoirs, miles of canals, and the main distribution system to the farms and other structures (Fig. 4). The engineer has the responsibility of determining the available water supply and requirements for irrigated crops, designing and building the structures essential to the storage, diversion, conveyance and distribution of water to the farms to be irrigated.

Usually a study of an entire drainage basin is necessary in planning large irrigation projects. Data are needed on soils, climate, stream flow, monthly and annual distribution of water, ground water, drainage, prior rights of water users on a stream or river, and the possibilities of storing surplus stream flows in years of high runoff. An investigation of the availability of a ground water supply may be required as irrigation projects often combine the use of surface and underground supplies to provide full water requirements. Also the quality of the available water, soils suitable for irrigation, and crops to be grown must be determined.

In the design and construction of dams, reservoirs, canals and other works for delivering irrigation water to the farms in adequate amounts for crop requirements, the application of engineering skills and judgment is essential to the successful completion and operation of a project (Fig. 1).

**Development of Farm Irrigation Systems**

Large areas of farmlands are supplied water for irrigation from projects constructed by Federal government or State districts, however, in many areas of the Far West, water supplies and irrigation systems have been developed by individuals or groups of farmers. A large number of irrigated farms have been developed with family labor and small-unit land leveling equipment. In recent years the preparation of large land areas for irrigation with heavy equipment has increased. Further development by both methods is feasible, but regardless of the type of farming or whether the land is farmed for the first time or had been cultivated before irrigation water was applied, a complete farm plan for water distribution is essential to insure maximum crop production and save later labor and expense. Developing land for irrigation without proper planning may result in earth being moved in the wrong places so that it must be moved again, requiring the relocation of ditches and other structures, creating alkali spots through over-irrigation and poor drainage, and other costly mistakes. Planning aid may be obtained from engineers and technicians of the United States Soil Conservation Service, the Bureau of Reclamation, from county agricultural agents or state agricultural college extension specialists.

*Clearing Native Vegetation:* The first step in preparing land for agriculture in the West is to remove native vegetation such as grasses, sagebrush, greasewood, chapparal and trees. Plowing is usually effective in clearing grasses, small varieties of brush and other native vegetation up to 1½ to 2-ft tall. Usually a heavy one-way disk plow is best for this work. The plowing should be deep enough to cut the roots without covering the brush, so that it can then be raked and burned.

Lands which produce brush 2 to 5-ft high are more expensive and difficult to prepare. However, such growths can usually be removed by railing, grubbing and plowing. Various brush grubbers and blade grader machines have been used successfully in removing sagebrush and similar growth. Blade graders and other machines are more effective in clearing brush than the railing method.

Heavy brush includes dense growths of saltcedar, mesquite, manzanita, and similar growths. The older methods of clearing brush and trees by grubbing and blasting are now restricted to small areas. In recent years great improvements have been made in methods of clearing heavy brush and trees. Heavy brush growths have been removed more efficiently by brush cutters mounted on heavy crawler equipment.

*Grading or Leveling Land:* After the removal of native vegetation, land to be irrigated usually requires grading or leveling in order that water may be distributed uniformly with a minimum of labor and expense. The amount of preparation required depends on the method of irrigation used, but in any case, all hummocks and hollows must be smoothed

*(Continued on page 421)*

Fig. 6 Irrigating citrus fruits by furrow irrigation

# Irrigation in the Middle West

**Ivan D. Wood**
Fellow ASAE

IT IS not known where irrigation was first practiced by mankind in the New World. The remains of a vast irrigation system built by ancient Indian tribes can still be seen today in Arizona. In the vicinity of Phoenix, in the Salt River Valley and along the Salado River, the birth of true irrigation took place in prehistoric America.

Probably about 700 A.D. a number of settlements were established in that area and in the next 500 years twenty large villages and an extensive irrigation system developed. A total of more than 125 miles of these ancient canals has been examined, some measuring 30 ft in top width and more than 10 ft in depth.

The builders of this primitive system, the Hohokam, are gone without a trace of their whereabouts or their descendants. We now ponder the great effort ancient man put forth to ward off the catastrophe of drought and crop failure. These ancient canals were built by scraping the earth into baskets with sharp stones—a task requiring years of labor by hundreds of workers.

The Jesuit Fathers, in more modern times, irrigated mission gardens along the Rio Grande and in California by ingenuous means, sometimes carrying the water long distances in crude tile lines made by burning native clay.

It remained for the Mormon pioneers to start the great crusade of supplementing natural rainfall with irrigation. On July 24 and 25, 1847, the followers of Brigham Young broke some desert land, diverted the waters of what is now City Creek for irrigation, and planted a field of potatoes.

The development since that historic day reads like a story book. From a field of potatoes to 30,000,000 acres scattered through all states of the Union. Most of these acres are in the West and Far West where natural rainfall is insufficient for crop growth.

Year by year irrigation is moving steadily eastward and southward. Once confined to an area west of the 100th meridian, irrigation has found great favor in the southern and southeastern states with an average annual rainfall of nearly 50 inches. It has moved to the states of the Middle West—to Iowa, Illinois, Missouri—where rainfall was once thought to be sufficient for all crop needs.

### Why Irrigation Moved Eastward

The great drought which has plagued much of the United States since 1949 is one reason irrigation agriculture has found favor outside of the arid West. While Texas, New Mexico, Oklahoma, Kansas, and Missouri have been hardest hit, much of the Middle West has suffered also. It has been estimated that 1,700,000 sq mi of area in 26 states have been affected. Streams have vanished, century old trees have died, and millions of persons have suffered economic loss and personal hardship. Science has not found the secret of weather control. As yet irrigation seems the main safeguard.

High cost of crop production has made crop failure a more serious handicap than it once was. Corn farmers have estimated the cost of producing an acre of corn at from $50 to $75 per acre. This figure includes seed, insect control, fertilizers, cultivation, land costs and harvest. The cotton farmer in the South may have as much as $100 per acre invested in his crop by the time it reaches the gin. Production expenses for the farmer have shown a steady increase since the year 1940 while total net income has declined since the high of 1947. Wherever possible, farmers have turned to irrigation as one means of avoiding the great economic loss which comes when a season's work and expense goes for naught.

Paper prepared expressly for the Golden Anniversary issue of AGRICULTURAL ENGINEERING.

The Author—IVAN D. WOOD—is an agricultural engineer, extension service, USDA, Denver, Colo

Fig. 1 Sprinkler irrigation has increased rapidly in the Middle West. It is better suited to certain site conditions than other types

The increased use of commercial fertilizers in recent years has favored the use of irrigation in the Middle West and elsewhere in subhumid and humid areas. In 1955 the cash grain farmer spent, on the average, about $780 for fertilizer and lime. In 1937 to 1941 this figure was about $60 per farm. With high use of fertilizer, total cost of production rises and higher yields are necessary for profit. Drought produces burning in many crops when high nitrogen fertilizer applications are made. Irrigation is the safeguard.

Acreage control has restricted the amount of various cash crops which the farmer can produce. With restricted acreage and no very profitable substitutes for cash crops, which he can grow only in limited quantity, the farmer attempts to produce as much as possible on the acreage he is allowed to plant. When conditions are favorable, irrigation furnishes the answer.

### How Much Irrigation in the Middle West

The Middle West has been described by various boundaries. The transition zone between arid and subhumid areas is generally placed somewhere near the 100th meridian, cutting through North and South Dakota, Nebraska, Kansas and Oklahoma. Since the eastern portions of these states have subhumid climatic conditions, this area will be included as part of the Middle West, but separate tables showing irrigation increase have been prepared for them since they are in a borderline area.

TABLE 1. INCREASE IN IRRIGATED ACREAGE

| State | Acres irrigated 1950 census | 1954 census | Estimated 1956 | Estimated 1966 |
|---|---|---|---|---|
| Missouri | 2,089 | 32,998 | 46,538 | 150,000 |
| Iowa | 1,386 | 2,396 | 20,000 | 75,000 |
| Minnesota | 4,235 | 9,207 | 15,000 | 23,000 |
| Illinois | 1,510 | 6,789 | 16,000 | 25,000 |
| Indiana | 5,339 | 11,738 | 30,000 | 75,000 |
| Michigan | 13,901 | 23,473 | 60,000 | 100,000 |
| Wisconsin | 9,781 | 18,199 | 15,000 | 20,000 |
| Ohio | 5,708 | 15,379 | 18,000 | 60,000 |
| Totals | 43,949 | 120,179 | 220,538 | 528,000 |

Accurate figures on irrigated acreage are very difficult to get. Even census figures are often unreliable since their accuracy may depend to a considerable extent upon the knowledge of the census taker. A man will report accurately the acres he owns or rents, his head of livestock, and the number in his family. When it comes to irrigated acres, one year he may irrigate a field of 40 acres of corn with four water applications and put one light irrigation on 80 acres of small grain. The next year he does not irrigate at all because of favorable rainfall, so he reports no irrigated land. The figures in the following table are given for what they are worth. In some states two USDA agencies—Extension Service and Soil Conservation Service—are making accurate surveys of irrigation and the results should be good.

TABLE 2. IRRIGATED ACREAGE OF BORDER LINE STATES

| State | 1950 census | 1956 estimate by agencies | 1966 estimate by agencies |
|---|---|---|---|
| North Dakota | 35,294 | 104,000 | 150,000 |
| South Dakota | 78,069 | 75,000 | 275,000 |
| Nebraska | 878,259 | 2,500,000 | 3,000,000 |
| Kansas | 138,686 | 700,000 | 950,000 |
| Oklahoma | 34,071 | 210,000 | 500,000 |
| Totals | 1,164,379 | 3,589,000 | 4,875,000 |

Fig. 2 Pumping plants have become marvels of design and efficiency. Underground water supplies have been endangered in some areas due to the great withdrawal by irrigation wells

The figures indicating irrigated acreage in the borderline states are interesting in comparison with other states of the Middle West. High risk of crop failure has hastened the adoption of irrigated agriculture in this area. Nebraska has about fifteen times as much irrigated land as do all the states listed in Table 1.

### Types of Irrigation Systems Best Suited to Middle West

Sprinkler irrigation has been the type most used in states of the humid and subhumid areas. There are, however, many site conditions which favor the use of gravity water application methods.

The sprinkler has many advantages for the uneven topography of some areas and for soils with very high or very low infiltration rates. It can be put into operation quickly and usually makes better use of water. It has the disadvantage of requiring considerable hand labor for hand moving and is awkward to manage in tall-growing crops.

Gravity or surface-application methods have a definite place on river bottom lands. The use of gated surface pipe eliminates ditches and is easily moved along the edge of fields. A properly designed system of this type is not more wasteful of water than a sprinkler, and requires less labor in tall crops.

Great improvements have been made in both gravity and sprinkler-system design. The wheel move, the tow move, and self-propelled sprinkler systems show great promise as labor savers. Ingenuous methods of towing long lines of sprinkler pipe in and out of corn fields promise to remove one of the great disadvantages of this system for use with tall-growing crops.

Bench leveling was used by the Incas of South America centuries ago and is "old stuff" to the peoples of Guatemala, Mexico, and the Far East. We have now adopted it in connection with gravity irrigation on sloping lands with great success for labor saving and erosion control.

The author has been somewhat disturbed by the attitude of some irrigation engineers with regard to system design. Site conditions should determine the type system to use for the good of the man who is to use it. Too often the lack of

Fig. 3 Powerful earth moving machinery makes possible the forming of land surfaces for efficient water application and better machine operation. A job which once required most of a lifetime to accomplish with horses and scrapers can now be done in a few days

knowledge of gravity-type irrigation has handicapped the engineer from making the best selection.

### Water Supplies for the Middle West

Water supply is the limiting factor in irrigation development for many middlewestern states. In large areas the farm pond will be the only source of supply and farm ponds have rather limited possibilities, in general. Even small ponds should be utilized to the fullest extent, but they are usually dry when water is most needed. A large watershed and large pond is needed for dependable operation, as many farmers have discovered in this drought period.

Unfortunately many smaller streams are not dependable supplies when the dry summer months or the unusually dry season comes. Long-time records of the U.S. Geological Survey or other agencies will usually give the answer.

Water from the larger rivers will be used to the fullest extent in the future. Water will be carried far inland by means of pipe lines or canals. This will be done on the Oahe project in eastern South Dakota. Water from a dam on the Missouri River will be pumped to a high canal which will carry it to another watershed for extensive irrigation use.

There is opportunity for the formation of cooperative irrigation projects in the states east of the Missouri River, just as is done in the West. In some cases a pump located near the stream could deliver water to a low-pressure pipe line. From this low-pressure line, farmers could operate sprinkler systems with individual pumping plants. A good operating arrangement is to pump through the low-pressure line to a reservoir containing several hours supply for as many farms as would be allowed to irrigate at once. By use of a reservoir, the pump supply does not have to be so closely regulated to water use by irrigators.

Cooperative systems of the high-pressure type are in operation in arid regions. The individual farmer does not use a booster pump since pressure in the main system lines is sufficient. Careful scheduling of operation is necessary and charges are based on amount of water used.

Many rivers in the Middle West are subject to great fluctuations in water level during flood times. Several successful installations have been made by mounting the pumping plant on a car which moves up and down a track laid on the river bank. The equipment is raised and lowered as the water level changes. Connection from pump to main lines is made through flexible pipes. Another type of installation consists of a floating barge on which the pumping plant is housed. The barge, stabilized by cables to trees or piling, rises and falls with the river level. Often these installations are set in a cove away from the main river current.

Fig. 4 Field trials have greatly improved the efficiency of surface irrigation methods. Here measurement of flow is being made with a small Parshall flume to determine safe size of furrow stream to prevent erosion

### Water Laws and Water Rights

Very closely associated with irrigation is the matter of water laws and water rights. In many states outside of the arid regions, water laws and water rights are clouded and obscure. Some have no water laws pertaining particularly to irrigation. No great expansion of use of rivers and streams for irrigation can be expected until water laws take a more crystallized form.

Water use, in many states of subhumid and humid areas, is governed by the riparian doctrine which holds that the water of the stream can be used only by those whose land borders the stream and that water must be returned to the stream undiminished in quantity and quality. Obviously this law, if followed to the letter, eliminates irrigation from streams.

Several states in the Southeast have made good starts toward a workable water law. A water policy committee appointed by the governor of South Carolina has suggested to the state legislature a bill which will bring some order to water use, if adopted. This bill suggests some phases which could well be studied by other states where no formal laws have been passed regarding water use. The suggested bill provides for the following:

*Protection of Vested Rights.* Vested rights to surface waters are guaranteed for those who are now using surface water for beneficial purposes. It provides for additional uses to be developed legally.

*Legal Use of Surface Water.* After a specified date, no person shall take water from a stream, lake, or other watercourse without a legal right to do so. Violators are subject

to punishment. Exempted are those who build ponds on their own land to collect surface runoff from such lands or those whose lands contain ponds or lakes with no surface outlet.

*Application to Use Surface Water.* All persons must apply for a right to use surface water in water courses or to dam it for use with the exceptions noted. The use of surface water shall be subject to the principle of beneficial use. "Beneficial use" is defined as that which is for some useful industry or to supply a well-recognized want.

*Precedence for Use.* Future appropriations of water for different purposes shall take precedence in the following order: domestic, municipal, irrigation, industrial, recreational, and power.

*A Board of Water Commissioners.* Water policy is to be administered by a board of water commissioners appointed by the governor with the consent of the senate. One member is to be appointed from each congressional district and one from the state at large. The board is empowered to employ a water engineer and such other assistants as are deemed necessary.

*Forming of Water Districts.* The board will be empowered to form water districts as necessity arises. Persons using water in any district will contribute to the cost of operation of such district.

*Survey of all Water Supplies.* The board of water commissioners is empowered to complete a survey of all water supplies both underground and surface—control of all supplies to be coordinated for the best interests of all concerned.

The suggested bill contains many other provisions, but is not as complicated as the water laws of many western states. Amendments made from time to time will care for special conditions which will arise.

So-called "water authorities" have been made legal in some states. In some cases the laws governing these authorities exclude from control water used for agricultural purposes. All other water uses within the area of the authority are subject to control. Though this law may appear to have little bearing on the agricultural usage of water at present, it is very possible that it may be broadened to include it at some future date. Also, agricultural usage may be vitally affected by use for industry and other purposes.

### Future Development in Middle West

Future development of irrigation in the middle West is difficult to forecast. A long period of favorable rainfall would deter development while drought years would encourage it. Some areas have started a comprehensive study of weather through past years to determine the frequency of damaging drought periods and thus establish irrigation need.

It is a fact that irrigation agriculture has been creeping slowly eastward, even into humid regions of the South and East, and this development can well be expected to continue.

In arid regions, irrigation is a must and the farmer always prepares to apply water just as surely as he plants and harvests. In the humid and subhumid areas, he is never sure whether irrigation will be necessary or not. There is a tendency to wait too long when drought does appear and to lose crop yields because of delay.

An encouraging aspect of irrigated agriculture in the Middle West is the imaginative way in which scientist and farmer alike have undertaken to solve the problem by research and experience uninfluenced by the customs and prejudices of the Far West where irrigation knowledge has often been handed down from the dim past.

## . . . Irrigation in the Far West

*(Continued from page 417)*

out. If these are only a few feet in diameter and less than a foot high, this can be done by a home-made wooden leveler, or float, or by a factory-made steel machine. Some farmers grade with scrapers. In recent years, however, the tendency has been to use earth-moving equipment powered by tractor and on a hired basis (Fig. 5). When a farm is to be irrigated by flooding from field laterals, this usually will be all the leveling needed and field ditches will be so located as to reach all the high spots. Usually little leveling is necessary if sprinklers are to be used for irrigation. For furrow irrigation, a nearly uniform slope of land is needed to avoid water and soil losses. Careful leveling is required for border irrigation.

*Farm Distribution Systems:* In planning a farm system, consideration must be given to the slope and shape of the ground surface, the nature of the soil and subsoil, the crops to be grown, the amount of water available, and the way it is to be delivered. The irrigation method adopted is based primarily on these factors. Since the water supply from a main irrigation system is delivered from a canal lateral to the farm headgate, this headgate may also serve as a measuring device. It should be located at or near the highest point in the farm. The farm distribution system may consist of farm ditches, flumes, pipes or other conduits needed to transport the water from the delivery headgate to different parts of the farm, and other structures which will regulate the distribution to the fields. The system should be designed to fit the method of irrigation to be used.

In some areas where the water supply is limited and the costs are high, underground pipe is being used to conserve water and labor. In western states, especially Arizona and California, the use of concrete is increasing rapidly. More than 30,000 miles of concrete irrigation pipe have been installed in California alone. High irrigation efficiencies are obtained with underground systems, since large seepage and evaporation losses are not possible.

### Outlook

Besides creating a greater demand for industrial and municipal water, population pressures will expand the need for more food and fiber. This, in turn, will cause the extension of irrigation to areas not now considered economically feasible for development. Greater use of hill lands will be made largely through the use of sprinkling, great multipurpose projects will be constructed, water cost generally will increase, and a higher degree of automation will take place. Unless properly handled, our ground water basins will deteriorate in effective capacity and quality of water. Much attention will be given to the improvement of irrigation systems and efficiencies of water application, and to the study of the possibility of augmenting fresh water supplies by such means as saline water conversion, cloud seeding, and watershed management. Research on soil and water management will be the key to the development of a permanent irrigation agriculture in the West.

# Progress in Erosion Control Over the Past 50 Years

**M. L. Nichols and D. D. Smith**
Fellow ASAE Fellow ASAE

ACCELERATED erosion has generally been associated with tillage of steep or rolling land. The opening of extensive new areas for cultivation, as in the prairies and high plains, and the increase of row-crop land per operator with the decrease of soil conserving feed crops for horses and mules, has tended to increase soil erosion. This background of speed-up production by mechanical power and mechanization, as well as the use of this power for applying remedial measures, must be considered in evaluating progress in conservation. In many cases power has proved both the cause and the cure of erosion.

Parallel with this development of mechanical power there has developed a consciousness of the serious threat to our basic resource, the soil, and well-planned vigorous educational campaigns moved forward hand-in-hand with scientific advancements to develop an effective national program of erosion control. In this brief summary of progress only a few of the important steps can be pointed out and only a few of the devoted men who worked for years to advance this program can be mentioned.

### Early Work in Erosion Control

At the beginning of the century, erosion was recognized as a serious problem by many farmers and scientists, particularly in the Southeast. Through Virginia and the Carolinas, before the beginning of the century, farmers constructed hillside ditches intended to conduct water at a non-erosive velocity from the field but in general the maintenance of such structures was exceedingly difficult. In most areas of the Southeast, the ditch idea was abandoned and across-the-slope levees, usually called narrow-base terraces, were constructed to take their place. Since this levee caught and held the soil, in many cases bench terraces developed. The idea of terracing was generally accepted throughout the South.

Priestly M. Mangum, a farmer near Wake Forest, N.C., in 1886 by the simple process of plowing to the narrow levee, produced a broad ridge with a water channel above and in effect secured a rolling topography with greatly reduced slope hazard over the entire field. This marked the beginning of the era of the broad-base ridge terrace.

During this period, the state agricultural extension services began their effort to get the farmers to terrace. The movement began in the South and spread to the Midwest. Construction plans for homemade terrace drags and step levels were brought to the attention of farmers. An inexpensive farm level, the Bostrom-Brady, was put on the market and in Alabama, for example, each county agent was provided with one of these levels and instructed in its use for general educational purposes. The agricultural engineering department at the Alabama Polytechnic Institute was set up in 1919 with erosion control as its first objective. Soon the manufacture and sale of steel drags and terracers began; for example, the Martin ditcher, the Corsicana terracer, and the Caterpillar No. 1. Terracing schools were held for farmers and required courses put in the college curriculums. There was great enthusiasm for terracing. In Mississippi, Daniels Scoates, professor of agricultural engineering at Mississippi State College, secured the cooperation of several ministers and sermons were prepared and delivered by all of the leading religious denominations.

The primary objective of this early terracing was the handling of rainfall excess so as to prevent gullying. Woods or pastures were used as outlets and the terrace outlets were distributed over as wide an area as possible so as to avoid concentration of runoff. Extensive experience developed the concept of the terrace channel being dug into the soil so as to avoid the danger of breaking of the levee used in the broad-base terrace. The resultant structure was called the channel or Nichols-type terrace to distinguish it from both the narrow ridge and the broad-base terraces. This type of ditch is hydraulically sound and is still in extensive use.

### Early Research Work

Early research relating to erosion and its control had its beginning shortly after the start of the present century. One of the first technical publications dealing with erosion was: Soil Survey of Fairfield County, South Carolina," by the Bureau of Soils, U.S. Department of Agriculture, in 1911. The Department published in 1917 a bulletin, "Prevention of Erosion on Farm Land by Terracing," which was the result of a study of terracing throughout the Southeast by C. E. Ramser. In 1917, M. F. Miller, at the Missouri station, started the first measurements of runoff and erosion from small plots under different cropping conditions. This had been preceded two years by similar measurements from forest areas in Utah by the Forest Service, U.S. Department of Agriculture. The Alabama station in the early 1920's set up experimental erosion control studies using artificial rainfall to evaluate cover by plants on different slopes.

During this period, H. H. Bennett of the Soil Survey, U.S. Department of Agriculture, studied the effects of erosion throughout the South and published a number of technical and popular papers as to its seriousness. At first he encountered considerable difficulty in his own organization as the survey was primarily concerned with soil classification, but his perseverance and enthusiasm attracted national attention, although it was not until 1929 that any specific action was taken. At that time, the Buchanan amendment to the 1930 federal appropriation bill author-

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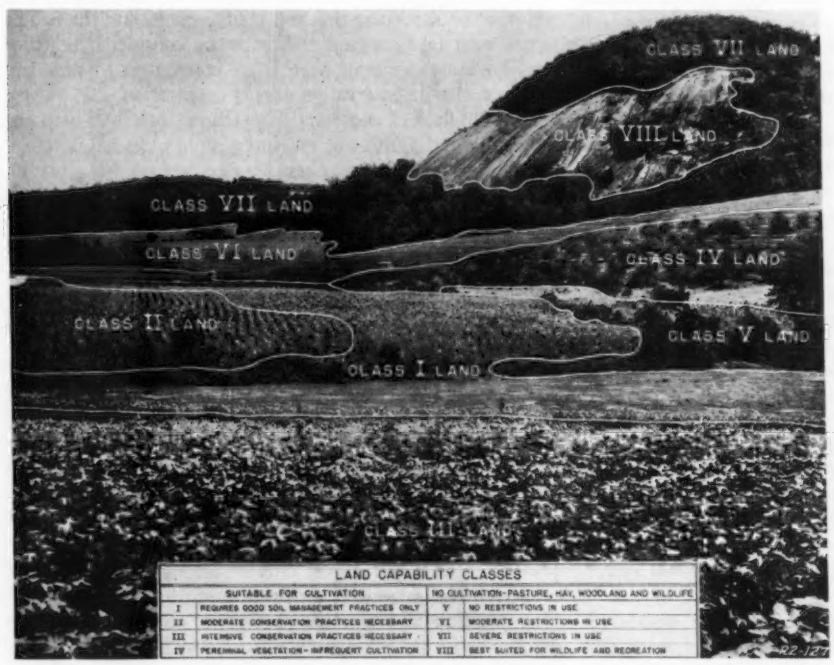
Fig. 1 At Auburn, Alabama, sloping land is farmed efficiently with four-row equipment. Parallel terraces and land forming eliminate "point" rows

ized $160,000 for soil erosion investigation. Bennett immediately requested the cooperation of the states and set up ten experiment stations in Texas (3), Oklahoma, Kansas, Wisconsin, Ohio, Missouri, Iowa, and North Carolina. The technique Miller and his associates developed for evaluating the actual loss under measured soil, crop, and climatic conditions was used, although in somewhat modified form, by these ten federal-state stations.

In these early experiments, the value of ground cover by plants was shown to be of prime importance for the correction of sheet erosion and rilling. The general concept of erosion control as a joint responsibility of the agronomist and engineer generally began to be accepted. It is now considered the job for a team of scientists consisting of engineers, crop and soil scientists, and — farm management specialists.

## Rapid Development of Program in the Southeast

While the agricultural experiment stations were gathering much needed information about erosion and its control, the agricultural extension service educational and developmental program was rapidly expanded. With the advent of the tractor, the farmer had for the first time a concentrated source of power with which he could move "dirt" easily, and the tractor industry entered enthusiastically into demonstrations. Better soil-moving equipment was developed specifically designed for terracing. Laws were passed in a few states permitting the formation of terracing associations with public support. Fletcher Farrington, the county agent at Dadeville, Alabama, was a leader in this activity and during the depression of the thirties—with the strong support of his county officials, the extension service, and the tractor industry—an arrangement was made with the relief admin-


CLASS VII LAND
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CLASS VI LAND
CLASS IV LAND
CLASS II LAND
CLASS V LAND
CLASS I LAND
CLASS III LAND
LAND CAPABILITY CLASSES
SUITABLE FOR CULTIVATION
NO CULTIVATION-PASTURE, HAY, WOODLAND AND WILDLIFE
I REQUIRES GOOD SOIL MANAGEMENT PRACTICES ONLY
II MODERATE CONSERVATION PRACTICES NECESSARY
III INTENSIVE CONSERVATION PRACTICES NECESSARY
IV PERENNIAL VEGETATION-INFREQUENT CULTIVATION
V NO RESTRICTIONS IN USE
VI MODERATE RESTRICTIONS IN USE
VII SEVERE RESTRICTIONS IN USE
VIII BEST SUITED FOR WILDLIFE AND RECREATION
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Fig. 2 Correct land use is necessary for conservation. The "capability" concept has been useful

istrator under which the counties were authorized to buy with federal funds a tractor and a terracer to get started on a self-liquidating county terracing program. This program spread throughout the Southeast.

### Conservation as a Relief Measure

The activities, federal and state, sketchily described above, brought the need for erosion control to the attention of the general public, and when the federal government decided to stimulate business by a great increase of public works, the conservation program was an important beneficiary. On September 19, 1933, H. H. Bennett was transferred from the U.S. Department of Agriculture to the department of the Interior where he was made director of the Soil Erosion Service. He developed a program and organization under which in the next two years, forty well-staffed demonstration projects were put in operation. On April 1, 1934, twenty-two emergency conservation camps of approximately 200 boys and young men each were assigned to the Soil Erosion Service. These camps, with their labor and equipment, were assigned to many different conservation jobs, the most common of which was gully control using mechanical-hydraulic structures. This field application work sparked the beginning of research in structure hydraulics at the Wisconsin experiment station in 1933 and the development of gully control methods under the leadership of O. R. Zeasman of that station.

Since the demonstration projects of the Soil Erosion Service were right in the middle of the field of the Department of Agriculture and since the federal and state extension services were considered to be the agricultural demonstration agency, there soon developed a determined fight to move the program to the Department of Agriculture and avoid duplication. The Soil Erosion Service remained in the Interior Department until March 1935 when it was considered sufficiently developed and organized to continue as a separate organization and to maintain itself as a unit of the Department of Agriculture. The ten erosion experiment stations and a number of nurseries supplying grass and erosion control plants were transferred to this unit.

### Creation of a Permanent National Agency for Soil Conservation

In April 1935, Public Law No. 46, 74th Congress, directed the Secretary of Agriculture to establish an agency known as the Soil Conservation Service, and this became a permanent government agency with status similar to that of the Forest Service. By December 27, 1935, the Soil Conservation Service had 10,325 employees scattered throughout the United States. The conservation program grew rapidly due to its immense popularity and the Soil Conservation and Adjustment Act was based on the value of erosion control and the associated water conservation. A couple of years later, February, 1937, the President addressed a letter to the governors of the states and urged that the separate states set up their own laws governing the formation of soil conservation districts and proposed a standard law. Arkansas passed the first district law the next month and the other states one after another set up their own laws under which the districts are now operating.

Along with this rapid development of an organized national program, three new national societies were developed to support the movement: The Friends of the Land, the Soil Conservation Society of America, and the National Association of Soil Conservation Districts. The formation of the Soil and Water Division (originally "Land Reclamation Division") of the American Society of Agricultural Engineers was a major contributing factor in the development of erosion control. These have all been of great help to the conservation program.

### Continuous Technical Development

The progress in the technical phases of soil erosion control has kept up with and in general has led the organizational development. The Soil Conservation Service expanded the research under way on the ten federal-state stations into a comprehensive research program in cooperation with practically all of the state agricultural experiment stations. This program was continued and increased in scope with transfer of research activities to the Agricultural Research Administration in 1952 and later the Agricultural Research Service where it now has division status. The research approach developed by the U.S. Department of Agriculture from the beginning has been to attack a problem with a team of highly trained engineers and soil and plant scientists equipped to do basic research if and as necessary for the development of practical solutions to the problems. Developed solutions to problems are tested on field and farm-sized areas to complete the applied phase of the research and to insure their practicability.

All through the development of erosion control measures, the farm equipment industry has continuously and consistently cooperated most effectively. Looking back over this period of growth and development, one recalls many men whose devotion to conservation of the land and whose vision was far above and beyond immediate sales prospects. In this they were supported by the practical vision of their companies. Their commercial advertising has been a real educational force. It should be noted that the Farm Equipment Institute and the National Retail Farm Equipment Association recognize that soil management, and the equipment used in managing soil, must be considered together and both organizations have active committees to stimulate dealer and soil conservation district cooperation.

In the field of conservation practices, including both engineering and agronomic measures, rapid technical developments have been made. These have become quickly a part of a practical applied program. Only a few can be mentioned.

Outstanding measures, basically agronomic in nature, developed for erosion control by these groups, and generally adopted for field use are grass-based rotations, contour strip cropping, crop-residue mulches and fertility treatments. Grass-based rotation refers to cropping systems in which cultivated row crops follow one or more years of meadow crops in which grasses predominate. Their value is not only in providing increased soil cover but in creating a soil condition that resists the beating action of raindrops and the force of flowing water. They have been the basis for the agronomic program of the U.S. Soil Conservation Service.

Strip cropping, in which contour bands of sod crops alternate across the slope with bands of cultivated crops, has proven popular and highly effective in many parts of the country. The vegetative strips slow down overland flow, filter out soil and increase absorption of moisture. The practice relies on grass-based rotations, an effective fertility

Fig. 3 Terracing and smoothing for control of erosion and surface drainage is key to soil management in some areas • Fig. 4 "Land forming"—a rapidly expanding practice for conservation and efficient operation of big production equipment—has proved economical in many areas

program and grass waterways for efficient erosion control. It has been found most effective when used in conjunction with a terrace or diversion drainage system to reduce the length of slope and consequently the volume of overland flow.

The crop-residue mulch practice, largely developed by F. L. Duley and J. S. Russel in cooperation with the Nebraska station, has proven to be one of the most effective means for erosion control on cropland. It utilizes sweeps or other subsurface tillage implements which leave plant residues or stubble on the soil surface to protect it from packing and erosive action by the raindrop. It has been developed in many forms to meet various conditions. For example, at Blacksburg, Virginia, sod was inverted so that the root crowns were on the surface to produce an effective cover; in the Midwest, the residue is largely cornstalks, and on the high plains it is wheat stubble.

Widespread use of crop-residue mulches has not as yet been attained in the humid states. This practice can do much to reduce excessive runoff and erosion in these states and warrants much wider adaption. There have been stand and yield depressions in addition to operating difficulties with equipment not designed for efficient handling of the mulch materials and too efficient conserving of rainfall during prolonged wet seasons. Basic research is underway in South Carolina, Iowa and Illinois to solve these problems. The applied phase is also moving forward at these and many other locations. Farm equipment for efficient handling of mulch material is now available.

Correction of plant-nutrient deficiencies in soils is basic to establishing and maintaining vegetation for reduction of runoff and erosion. Investigations to determine fertilizer and lime needs of crops and soils, the development of improved fertilizers, better methods of fertilizer application and improved diagnostic techniques for recognizing nutrient deficiencies have helped considerably in obtaining effective soil and water conservation.

Minimum tillage is a new and promising concept under development that has a high potential for efficient production and conservation of soil and water. Work on this "practice" is under way in New York, Wisconsin, Virginia and several other locations.

The erosive power of the raindrop was carefully studied by several workers: first by J. O. Laws and D. A. Parsons at the National Bureau of Standards in Washington and at the Alabama Station, and later by W. D. Ellison at the Coshocton, Ohio, Hydrologic Research Station. The potential of this powerful erosive force has been well established. This knowledge has recently been used by ARS research workers to develop a mathematical relationship by which four parameters of rainfall energy and intensity, all readily determined, account for over 90 percent of the variation in individual storm soil loss data from fallow plots.

In the area of vegetative exploration, the Soil Conservation Service nurseries have made many valuable contributions. They developed methods of propagating and using several valuable grasses, an outstanding example of which was buffalo grass. They extended the use of many other plants, such as kudzu, lespedeza, sericia, and many shrubs, vines, and larger plants useful for windbreaks.

Extensive technical developments in grade stabilizing and runoff-control structures and in hydraulics of grass channels have been made at the St. Anthony Falls hydraulics laboratory of the University of Minnesota and the outdoor hydraulics laboratory at Stillwater, Oklahoma. Outstanding work was performed in sedimentation at the California Institute of Technology hydraulics laboratory. Early work in wind erosion control at the Amarillo (Tex.) experiment station and the fundamental work at the Kansas station has advanced our knowledge of the dynamics of wind erosion. Studies of the erosive effect of snowmelt were made in the Palouse area where chinook winds frequently melted snow so fast that fields suffered severe rill erosion. Basic work on snowmelt was carried on for a number of years at the Michigan experiment station.

The slope-practice method of applying conservation practices to the land has received special emphasis the last few years by both the Agricultural Research Service and the Soil Conservation Service. This method represents an engineering-type approach to the design of farm conservation plans. It started in Missouri about 1940, was developed in Iowa, and then generally adopted by the Soil Conservation Service throughout the Midwest and the Northeast. It is now spreading to most other sections of the country.

The Central Statistical Laboratory established at Purdue University in 1954 by the Agricultural Research Service has materially speeded developments of the mathematical relationships of erosion to slope, cover, soil, rainfall, and con-

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# Fifty Years of Development in Farm Buildings

**Wallace Ashby**
Life Fellow ASAE

Fig. 1 Horses and men did most farm work before 1910. Small gasoline engines and windmills were used for pumping water

Fig. 2 A Louisiana farmhouse built in 1905. Note ample size, stone pier foundation

Fig. 3 *(Above)* Ice from pond or river supplied refrigeration on the farm of 1910. Many farmers cooled milk and butter in spring or well water

Fig. 4 *(Right)* The hay carrier and track provided a way to use horse power for filling high mows

FIFTY years go back to the administration of President Theodore Roosevelt. The Panama Canal was being built and the United States was growing rapidly as a world power. If rising prices are an indication of prosperity, American agriculture was prosperous, for the value of farm property doubled between 1900 and 1910.

The following figures give a rough comparison of the status of agriculture in the United States, 50 years ago and now:

| | 1910 | 1955 |
|---|---|---|
| Population of the United States | 92 million | 165 million |
| Farm population | 32 million | 22 million |
| Number of farms | 6.36 million | 4.78 million |
| Average size of farms | 138 acres | 242 acres |
| Average value of buildings per farm | $995 | $5130 |
| Index of farm construction costs (1910-1914=100) | | 406 |
| Harvested acreage | 325 million | 345 million |
| Number of horses and mules | 24 million | 4 million |
| Number of tractors | ——— | 4.7 million |
| Number of milk cows | 21 million | 20 million |
| Total net farm income | $4,703 million | $13,429 million |
| Index of farm output (1910-1914=100) | | 180 |

While it depended almost entirely on horse and manpower, (except that grain was threshed with steam power), United States agriculture 50 years ago was a tremendous industry and highly mechanized as compared with that of other countries (Fig. 1).

## Farm Buildings of 50 Years Ago

Investment in farm buildings 50 years ago was relatively as large as now, and the buildings were probably as advanced as the field operations. The typical farmhouse (Fig. 2) was adequate in size, but poorly planned and lacking in facilities that we now consider important. Many had

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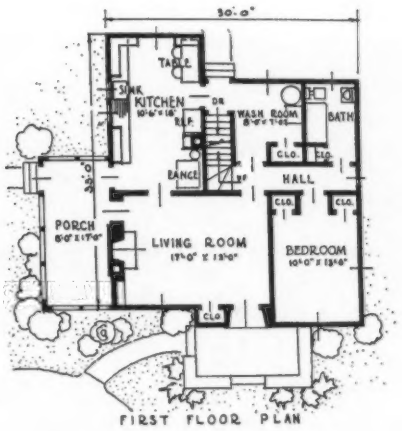
## 1934 Farm Home

Fig. 5 A medium-priced farmhouse design of 1934




"grown" by addition of rooms without proper planning, so that a person had to pass through one bedroom to get to another. There were few clothes closets and those were small. Most houses were heated by stoves or fireplaces and in cold winter weather the entire family might move into two or three rooms. Very few houses had piped water supplies or plumbing. Since cooking was on a coal or wood range, the kitchen was the best-heated room in the house, and the most used by the family. However, it was not a satisfactory work center because of traffic paths and lack of sink, running water, refrigerator or built-in cupboards. The man of the house coming in to meals was likely to hang his rather smelly coat by the kitchen door, dip water from the water bucket or the reservoir at the side of the range and wash at the kitchen table, or on the back porch. Farmers' Bulletin 126, "Practical Suggestions for Farm Buildings," published in 1901, presented a plan for an $1100 farmhouse. It included living room, parlor, kitchen with pantry, two large and two small bedrooms, each with a very small closet, a front porch and a cellar under half the house. This house was planned for stove heat and a wood or coal kitchen range, but no plumbing. The estimated price of $1100 amounted to 63¢ per sq ft, with lumber $12 per thousand board feet and carpenters $2.50 per day.

My parents built a new home on our farm near Des Moines, Iowa, about 1900. It was 30 ft square, two-story with 8 rooms and bath, full basement with attached storm cave for tornado protection and vegetable storage, and an attic and front and back porches. The walls were sheathed and weatherboarded and plastered inside. The attic was floored, but there was no insulation. Heating was by piped warm air furnace, cooking on a coal range. There was an ice refrigerator on the back porch, supplied with ice hauled from the river 3 miles away and stored under sawdust in our own icehouse (Fig. 3). Water supply was from a storage tank in the attic, filled by hand pumping. Plumbing fixtures included sink, with piped cold water in the kitchen, tub and toilet in the bathroom. House sewage drained to a cesspool. To save pumping water, an outdoor privy was generally used in good weather. Kerosene lamps furnished light at night; later in the principal rooms we had mantle lamps burning gasoline stored in an outside tank and supplied through a hollow wire. This house cost $3,000. It would be considered a good house today except for an inconvenient kitchen, lack of modern equipment, and no insulation.

The service buildings on my father's 104-acre farm were rather typical of the time. The original horse barn built in 1900 was about 32 by 48 ft. It had stalls for 6 horses, a box stall and storage for hay and grain. It was framed of heavy timbers with mortised joints pegged together with oak pins, vertical board and bat siding and wood shingle roof. The foundation was of field stone. Floors of the horse stalls were of earth, all others of wood planks. The main floor was about 3½ ft above the ground and the space below was used as a hog shelter. The center bay was open to the

## 1956 Farm Home

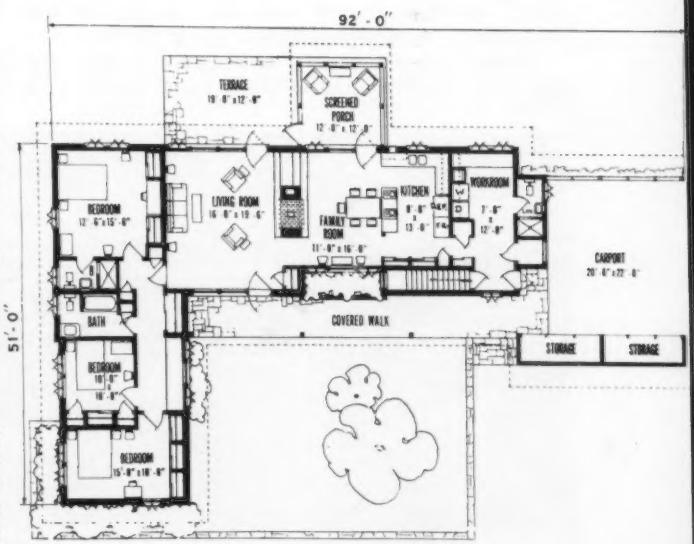



Fig. 6 A 1956 plan for a large farmhouse

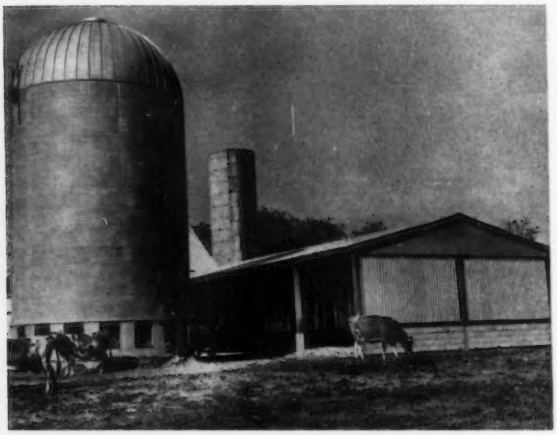


Fig. 7 Prefabricated loose-housing barn and self-feeding hay storage (U. S. Steel Corp.)

roof and had large doors at each end for use as a driveway. About 1905 the barn was lengthened by 32 ft. This part was framed with 2x6's and the roof was supported by posts and purlins. There was a large hay door in the gable end of the mow, which was filled with long, loose hay by a fork and carrier running on a track the length of the barn (Fig. 4).

This addition provided stanchions for 10 milk cows and pens for calves and young stock. Stalls were small and stanchions homemade of wood. Milk was carried to the house and separated in the basement. Skim milk was fed to the pigs and chickens. In winter chores were done by lantern light. The wood floor was a harbor for rats and the farm was never entirely free of them. At intervals we would have a rat killing, with dogs and clubs, but it was impossible to get them all. Another difficulty was with ventilation. The walls were of single boards and on cold days when the stable was kept closed for warmth, the atmosphere got pretty thick and smelly. Since tuberculosis was causing a great deal of concern, my father had his cows tested. We were shocked when three reacted and were slaughtered. The government stood part of the loss.

Young cattle and sheep were housed in a large, open pole shed, similar to those used now except that the poles were not creosoted. In addition, there was a large straw shed in the pasture about a quarter of a mile from the house. This shed was made by setting forked poles in the ground, laying poles in the crotches, and covering these with smaller poles at right angles. Then brush was laid on top and a thick coating of straw blown over the whole by the threshing machine.

Except for brood sows, the pigs slept under the barn which they considered very comfortable and it was hard to get them out in cold weather. We had two farrowing houses, each about 8x12 ft with two 6x8-ft pens for the sows. These were uninsulated and loss of young pigs in cold weather was heavy.

The poultry laying house was about 14x24 ft, uninsulated and open front with cheese-cloth curtains. There was a fenced yard for the hens in front of the house, but they often got out and were a nuisance around the buildings. Growing chicks were housed in movable brooder houses set in the orchard.

Vegetables and apples were stored in the storm cave which connected with the farmhouse cellar. This was of brick construction with an arched roof covered by about a foot of earth. This storm cave and the straw-covered cattle shed were the only insulated buildings on the farm.

There was no running water on the farm except in the house. Cattle were watered at a stock tank away from the barn except on very stormy winter days when water was carried to them. Water was carried to the pigs and chickens the year around, except that in summer part of the pigs ran on pasture and drank from a stream.

While all this may sound rather primitive, our farm had better buildings and equipment than most, except that we did not have a windmill.

### Development of the Farmhouse

The drudgery of farm life and lack of conveniences in the farm home have concerned public-spirited people for many years. For example, the report of the Commission on Country Life appointed by Theodore Roosevelt in 1910 had this to say about farm housing: "Theoretically the farm should be the most healthful place in which to live, and there are numberless farmhouses, especially of the farm-owner class, that possess most excellent modern sanitary conveniences. Still it is a fact that there are numberless other

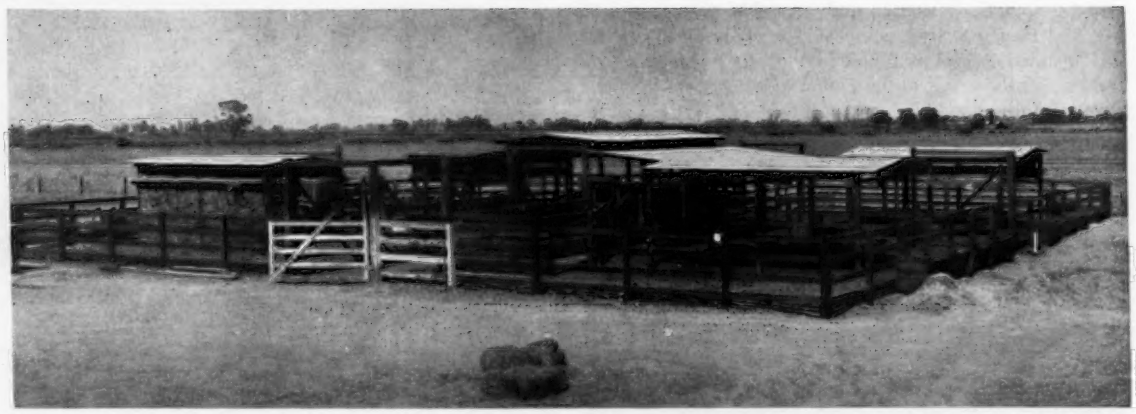


Fig. 8 The field shade increases summer profits from livestock in hot climates

Fig. 9 Auger-type conveyors distribute chopped hay or silage to feed bunks (James Mfg. Co.)

farmhouses, especially of the tenant class, and even numerous rural schoolhouses, that do not have the rudiments of sanitary arrangement.

". . . Whatever general hardships, such as poverty, isolation, lack of labor-saving devices, may exist on any given farm, the burden of these hardships falls more heavily on the farmer's wife than on the farmer himself. In general her life is more monotonous and more isolated, no matter what the wealth or the poverty of the family may be.

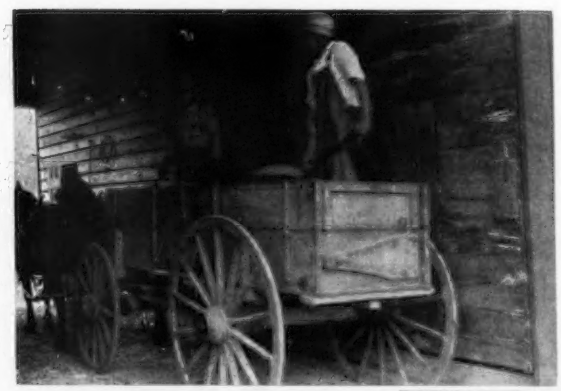


Fig. 12 *(Above)* The old way of moving grain from threshing machine to bin

Fig. 13 *(Right)* A galvanized steel corn crib of 1915. Walls are perforated for ventilation (Martin Steel Products Corp.)

Fig. 10 Chopped silage brought in self-unloading wagon and blown into the silo. Note hay-keeper at left (Martin Steel Products Corp.)

Fig. 11 A pair of bunker silos built of pressure-treated lumber. When filled the silage will be covered with plastic sheets weighted down with sawdust

"The relief to farm women must come through a general elevation of country living. The women must have more helps. In particular these matters may be mentioned: development of a cooperative spirit in the home, simplification of the diet in many cases; the building of convenient and sanitary houses; providing running water in the house, and also more mechanical helps; good and convenient gardens; a less exclusive ideal of money-getting on the part of the farmer; providing better means of communication, as telephones, roads and reading-circles; and developing of women's organizations." The farm press and farmers' organizations gave a great deal of publicity to the report of the Commission and helped to arouse interest in better farm housing.

The U.S. Department of Agriculture began the study of farmhouses in 1913. Field studies were made by Department architects in several parts of the country to learn actual conditions and farmers' wants. Following these studies improved farmhouse designs were developed and made available through publications and drawings. Other publications dealt with improved equipment and conveniences. Several of the state colleges began similar studies at about the same time. The farm press promoted better housing by publishing

## . . . 50 Years in Farm Buildings

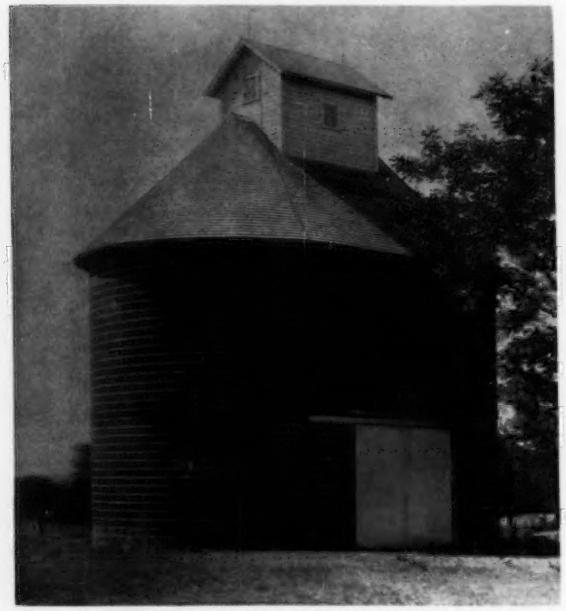


Fig. 14 A double corn crib with grain bins above the driveway and vertical elevator. A popular Corn Belt type developed before World War II (Structural Clay Products Institute)

house plans, offering prizes for plans and home improvement projects, and publishing articles on modern conveniences.

The President's Conference on Housing, called by Herbert Hoover in 1931, aroused a great deal of interest in improved farm housing and brought together a large amount of information on this subject, including a booklet of farmhouse plans.

The Farm Housing Survey, made cooperatively by USDA and the states in 1934, again focused attention on the need for better housing on farms and provided a new series of plans and publications. (Fig. 5).

In 1947, using funds provided by the Research and Marketing Act of 1946, a careful survey of farmhouse requirements was begun by the USDA in cooperation with most of the state colleges. These data are being used to develop designs for farmhouses and particularly for kitchens, that save effort and are more efficient and livable in every way. The present trend is toward open-planned, well-lighted, one-story houses with living room, dining room, kitchen, 3 bedrooms and bath. Opinion is divided on need for a basement (Fig. 6). The more elaborate house may include a family or recreation room. Emphasis is placed on good storage space and convenient arrangement, particularly in the kitchen and workroom. These plans are made available to all farmers through state extension services. Home economists and home demonstration agents deserve special mention for their efforts to help farm people obtain better housing. The farm press also has continually promoted better farm housing.

The spread of rural electric lines and the availability of bottled gas and fuel oil in almost all areas make it possible for more than 90 percent of farm people to have electric lights, and, for those who can afford them, hot and cold running water, plumbing, refrigeration, gas or electric cooking, automatic central heat, and summer cooling. Television, radio, and farm magazines arouse the desire for these conveniences.

Many fine, well-planned and well-equipped farmhouses have been built in recent years, but the majority of farm dwellings are still below city standards. For example, the 1950 Census found that only 25 percent of the farmhouses of the United States had complete bathroom facilities and kitchen sink; 33 percent cooked with electricity or bottled gas; 18 percent had central heating; 56 percent had no plumbing facilities in the house. In 1954, 94 percent of all farms had electric service but only 59 percent had piped running water in the house, 32 percent had home freezers, and 35 percent had television sets.

### Developments in Service Buildings

The farm service buildings of 1910 were reasonably well adapted to a horse-drawn economy, but they failed in many ways to meet the changed requirements brought about by tractors, power-operated machinery, other new developments and changed market demands. While changes have been slow and the cost has been high, great strides have been made during the past 50 years in developing buildings that meet present requirements. The development of dairies, creameries, grain elevators, CCC bin sites, chick hatcheries, and other off-the-farm facilities during this period has, of course, relieved the farm family of many earlier tasks.

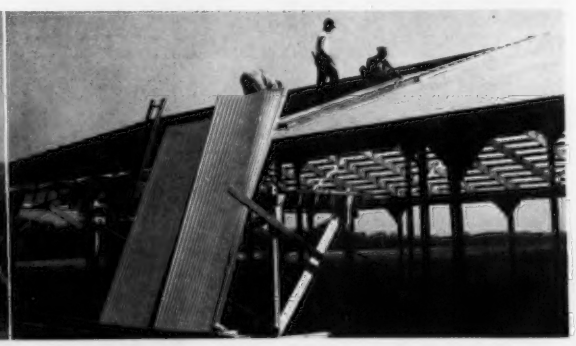


Fig. 15 *(Left)* A prefabricated building equipped for drying grain in storage. Manufacturers have cooperated with research workers in extensive tests of buildings and equipment • Fig. 16 *(Right)* A modern shed framed of pressure-treated lumber and roofed with corrugated metal sheets (Fig. 15, Stran-Steel Corp.; Fig. 16, Kaiser Aluminum and Chemical Sales, Inc.)

Shortages of labor due to wartime requirements, the competition of higher wage rates and better living conditions in cities, and the "cost-price squeeze" made it necessary for farmers to be more efficient in caring for their livestock and harvested crops. The ingenuity of a single farmer in finding a better way to do a certain thing has been the starting point for many a new development. His improvement caught the attention of a neighbor, a research worker, a farm equipment salesman, or a writer for a farm magazine and thus formed a link in the chain of improvement.

Federal and state research has made valuable contributions to better building design; for example, measurement of the pressures exerted by grain and silage on walls, floors and structural members; or measurement of the heat and moisture given off by the various animals and fowls at different temperatures, data needed for design of ventilation systems. State and federal publications, the cooperative farm building plan services, the extension service and the farm press, have brought information on improved building design to farmer's attention. Manufacturers of improved materials, equipment, and prefabricated buildings have all played a part.

### Livestock Shelters

*Changes in Types of Buildings.* The shift from long, loose hay to baled or chopped hay or grass silage has removed the need for huge hay mows and the trend now is to 1 or 1½-story buildings for all kinds of cattle. Stall barns are still widely used for milk cows, with feed stored in an adjoining building or a low mow overhead. Many farmers are adapting the loose-housing system for dairy cows, with open-shed bedded area, elevated stall milking room or parlor, pipeline milkers and bulk-tank storage, paved barnyard and self-feeding silo and hay feeders. Development of the loose-housing system is an outstanding example of agricultural engineering research and industry cooperation. Open sheds are generally used for other cattle and sheep.

Both central and colony houses are still used for swine; the farrowing stall is a widely used new development.

Central poultry houses have grown immensely. While widths of 12 and 14 ft were recommended 50 years ago, 30 to 60 ft widths are common now. Multistory laying houses are used on many specialized poultry farms. Cage housing is coming into wide use in the southwest and to a lesser extent in other parts of the country.

*Functional Planning.* The importance of planning for efficient flow of materials and of designing buildings to facilitate use of labor-saving equipment is generally recognized by agricultural engineers and by progressive farmers. Studies of time and travel on dairy, beef cattle, poultry and swine farms show that some farmers spend five to ten times as much effort in caring for livestock as their more efficient neighbors.

The convenience of driving a truck load of baled hay or straw into the building to unload and the use of the front-end tractor fork to handle forage and manure are opening up the interiors of cattle barns, poultry houses and other buildings. Various types of feed conveyors, and mechanical gutter and pit cleaners are available for use where it is not convenient to use trucks or tractors. The automatic water system providing piped water to buildings and lots is coming into very general use and is perhaps the greatest labor saver.

*Environmental Control.* Cooperative research by the USDA and state experiment stations has shown the importance of protecting livestock from high as well as low temperatures. The control of temperature, relative humidity and condensation in buildings has been greatly improved by the development of the various types of thermal insulation, of double glass windows, and fan-ventilation systems with thermostatic controls. Spot control of temperature for baby chicks, pigs and lambs is provided by heat lamps or by electric or radiant gas brooders. These have greatly reduced mortality of young animals and poultry.

The use of field shades of insulating or reflective materials, sometimes in connection with fans for creating air movement, adds greatly to livestock comfort and promotes growth during hot summer weather. (Fig. 8).

Sanitation is promoted by the use of concrete floors and impervious walls, as well as by the use of water under pressure for washing down milking rooms, feeding floors, and the like. Better natural and artificial light aid sanitation and make work easier. The use of electric lights controlled by time clocks in poultry laying houses to lengthen the day and increase egg production is almost universal.

### Buildings for Storing Forage

The storage of baled hay on the ground in one-story barns has already been discussed. Another development is storage of chopped hay in either tower-type "hay keepers" (Fig. 7), or horizontal storages arranged for self-feeding. Either type of structure may be of metal or wood construction. Both chopped hay and silage may be moved to feed bunks by conveyors (Fig. 9).

Forced-air drying of hay and other forages with either natural or heated air improves feeding value and reduces field losses. Chopped hay, long and loose hay and sometimes loosely baled hay are dried in storage buildings fitted with slatted floors or systems of ducts to distribute the drying air. Field-baled hay in loose bales, on the other hand, is often dried on wagons or especially designed platforms before it is moved into storage. Power-operated conveyors and elevators are available to reduce the labor of handling the hay into and out of storage.

The typical upright silo of 50 years ago was built of wood staves. The alternate swelling and shrinkage of the staves as the silo was filled and emptied called for continual maintenance. Monolithic concrete, clay blocks and steel silos were being introduced. Ensilage cutters and blowers were used for filling but only man labor was available for throwing down and feeding the silage. Corn was the material most used, with sunflowers recommended where corn could not be grown. Today, corn silage is still widely used, but large amounts of grass, grain sorghum and other forages also are ensiled.

Today concrete stave, vitrified clay stave and metal upright silos (Fig. 10) have become well established. The airtight, glass-lined silo, a more recent development, is adapted to storing lower moisture silage than other types.

Power-operated unloaders for tower silos and rubber-tired carts or conveyors for moving the forage to the feed bunk greatly reduce the labor of handling this feed. Some tower silos have been adapted for bottom self-feeding the silage to cattle. Sturdy construction is required.

While the trench silo is relatively cheap, its use is restricted to sites that can be well drained. The bunker or

## . . . 50 Years in Farm Buildings

above-ground horizontal silo (Fig. 11) is now more popular. Like the trench, it can be filled by hauling in the green material and packed by driving the truck or tractor back and forth over the surface. One disadvantage of the horizontal silo has been the large surface exposed to air, and consequent spoilage. However, certain of the new plastic sheet materials have proved very effective in reducing spoilage when properly applied and weighted to stop flapping in the wind.

Silage in a horizontal silo can be self-fed to cattle rather simply by use of a movable feeding rack set against the face of the silage, or the silage can be removed and transported to feed bunks by a tractor fork.

Modern structures and methods of handling silage are resulting in greatly increased use of this valuable feed.

### Grain Storages

Before 1910, grain was handled on farms with the scoop shovel, bushel basket or wagon (Fig. 12). The height of cribs and bins was limited by the height to which a man could shovel, except in the case of bank barns where the loaded wagon was driven onto an upper floor. In that case the grain could be sprouted down by gravity. The steel grain bin came into use more than 40 years ago and with improvement is still widely used (Fig. 13).

The development of stationary and portable farm elevators after World War I paved the way for high grain-storage buildings. Figure 14 shows a masonry double crib with grain bins above the central driveway. Frame buildings, similar in principle but rectangular in plan, also were much used throughout the corn belt. These storages gave good satisfaction with small grain that was dry when stored and corn that contained not more than about 20 percent moisture. However, in wet seasons, much grain was too damp to store safely, and in most seasons there were advantages in harvesting early (and therefore at high moisture content) to avoid risk of storm or insect damage or loss of grain by shattering. The development of the picker-sheller and corn combine brought a need to harvest shelled corn with as much as 25 to 30 percent moisture. These factors led to the development of mechanical equipment to dry grain either during or before storage in a conventional corn crib or grain bin. Since best return on the investment in drying equipment requires that the drier should be used in turn for forage, small grains, corn and perhaps other crops such as peanuts, buildings with built-in air-distribution systems and convenient arrangements for moving the crop in and out are needed. Considerable progress has been made on buildings for drying in storage (Fig. 15), as well as equipment for batch drying with heated air before storage.

### Vegetable and Fruit Storages

Fifty years ago, winter vegetables and fruits were generally stored in cellars for protection against frost and unfavorably warm temperatures. Ventilation was provided by wind movement or gravity. However, in most sections these products could not be stored late in the spring. Much farm food was preserved by drying, pickling, or canning.

While cellars are still valuable for storage of small quantities of potatoes, cabbage, apples, etc., modern storages are generally of above-ground, insulated construction, or a combination of above and below ground construction. The above-ground building is easier to fill and empty because trucks or trailers can be driven inside. When this is not possible, power-operated conveyors can be used.

Good temperature and humidity control in well-insulated potato storages can usually be obtained by use of electric fans and thermostatically controlled dampers, set to bring in fresh air when the house is too warm or to recirculate the air in the house when the outside air is too cold to use for ventilation. In a large well-insulated house, the potatoes give off heat enough to prevent freezing except in the coldest weather.

Since apples store best at near-freezing temperature, modern apple storages are equipped with refrigeration and air-circulation systems to maintain constant low temperatures throughout. Such houses must be well-insulated for economical operation.

With properly designed and equipped storages, potatoes, apples, and other fall vegetables and fruits can be kept into late spring if necessary to obtain a favorable market. Grading and packaging these products require considerable labor and work space for these activities is provided in modern houses.

### Farm Building Materials

For many years the most used building materials on farms were native stone for foundation and chimneys, lumber for framing, wall and roof-sheathing, and floors, and wood shingles for the roof. In recent years monolithic concrete, concrete masonry, and clay tile have largely replaced stone for foundations, while brick, concrete blocks, clay tile, metal and manufactured boards compete strongly with lumber as wall materials. Asphalt shingles and roll roofing, asbestos-cement shingles and sheets, aluminum and galvanized steel now supply most of the roofing materials. Wood lath and lime-plaster for house interiors have been replaced by gypsum or metal lath and gypsum plaster.

Insulation of all types—fill, blanket, board, and reflective—is widely used in dwellings, poultry houses and other livestock buildings and in fruit and vegetable storages. Insulation has done much to make these buildings more comfortable for man and beast, and more effective in maintaining the quality of stored perishable products.

Perhaps the greatest innovation in construction of farm buildings is the prefabricated building, usually of metal, but often of wood, fiber board or other material. The list of prefabricated buildings includes, grain bins, flat storages for grain and equipment, movable farrowing and poultry houses, and even dwellings and barns. The manufacturers have shown much ingenuity in adapting standard types and sizes of buildings to a variety of uses.

Another type of building that has become very popular in recent years is the pole barn, using pressure-treated poles. While poles were widely used in farm construction more than 50 years ago, most species were short-lived and no satisfactory method of treatment was available. This brought pole buildings into disrepute and no doubt was largely responsible for the shift to more expensive construction. The availability of pressure-treated poles and planks now provides a low-cost and flexible type of structure that is finding a place on many farms (Fig. 16).

*(Continued on page 459)*

# Farm Building Trends

**Deane G. Carter**
Life Fellow ASAE

BUILDINGS that were quite all right for the farming operations of 1907 are completely unsuited to the needs of 1957. Striking changes in agriculture in 50 years have imposed an entirely new set of requirements on building facilities. These requirements in turn have created the trends that characterize modern functional farm buildings.

Some buildings in common use in 1907 have disappeared entirely or they are being supplanted by other facilities. Examples are the icehouse, smokehouse, cob house, coal shed, thresher shed, carriage house, well house and horse barn. It seems quite possible that others may be on the way out. Among these are the dairy-stall barn, overhead hay storage, bull barn, small farm-type poultry house, chick brooder, and ear-corn crib.

Building trends can scarcely be detected from one year to another, for they come about slowly and irregularly as new developments occur. Only a few new structures are built each year in any one community. Old buildings are continued in use even after they are outdated and written off as tax deductions. Many that were built before 1900 are still being used.

There is little or no opportunity to follow recommended new practices on small farms and for small-scale enterprises where accommodations are needed only for two or three cows, one or two litters of pigs, fewer than 100 hens, and crops of less than 500 bushels. Frequently important changes go unnoted because of modifications made of new features, and of the differences among farms, regions, and types of farming.

Paper prepared expressly for the Golden Anniversary issue of AGRICULTURAL ENGINEERING.

The author—DEANE G. CARTER—is professor of farm structures at the University of Illinois, Urbana.

Nevertheless a review of farm buildings over a 50-year period fairly well defines the changes that have occurred. In this length of time, the more permanent trends appear. Temporary effects of war, debt, depression, and rising costs can be discounted. Then it is possible to determine effects of such changes as from animal power to tractors, from hand methods to mechanization, from general farming to specialization, and from relatively small units to large-scale production.

In the field of construction, the principal shift has been from traditional, home-built or carpenter-designed local buildings to greater reliance on engineer-architect designs, prepared plans, manufactured materials and structural parts.

The net result of building changes is the "modern" farmstead with its attractive farm homes and functional service buildings, a high degree of mechanization, and an arrangement that combines beauty and utility.

By definition, a trend is a tendency, inclination, or drift in a particular direction. Thus trends in farm buildings may be toward larger or smaller structures, higher or lower costs, greater or less durability, on-site construction or prefabrication, and general-purpose or specific types.

Sometimes a single change in production is sufficient to cause a new building trend. For example, the advent of tractor power gave new emphasis to the farm shop and machinery storage. It also did away with the need for horse barns with their feed rooms and overhead haylofts.

Generally, though, several factors combine to create trends. Hay-storage structures are affected by varied production practices such as chopping, baling, barn curing, and ensiling of green forage. Corn storages are in process of complete redesign, directly because of increasing mechanization, long-season hybrids, and need to reduce storage losses.

Fig. 1 Solar warmth through insulating-type windows contribute to better conditions in hog houses (Libbey-Owens-Ford Glass Co.)

Fig. 2 Research and industrial design produced this complete, elevated-stall milking unit (Hervey Research and Development Co.)

Principal factors that create farm-building trends may be grouped under headings of *(a)* production, *(b)* management, and *(c)* structure. Although most of the observable trends have to do with size, shape, type, materials or construction, these are important only as they also contribute to effective production or economy of management. Considered only as structural devices, buildings are inert and static, good only for storage and shelter. Their value lies in the facility to save labor, prevent waste, speed production, increase profit, improve conditions or better the quality or quantity of products.

Production requirements greatly affect the type and kind of building. Whereas the usual old barn was a general type providing for horses, cows, feed and forage under one roof, today's demand is for specialized enterprises and special facilities. Dairy production, for example, calls for clean products, healthful environment, labor-saving arrangements and conformity to grade A codes. Hogs must be produced under sanitary conditions and with reasonable environmental control to avoid excessive losses. Profit from beef production depends upon efficient layout for feeding and shelter. Grain crops require handling to control moisture, prevent contamination, exclude insects and rodents, and avoid loss in market grade or feeding value.

In every case, the building design must conform to production needs. Thus trends in the basic plan, structure, equipment and location are determined by research and experience in farming methods.

Management is closely related to production and likewise affects the nature of buildings. Investment costs must be kept down, labor used effectively, the size of each enterprise set at the most profitable level, and attention given to such things as crop rotations, land productivity, soil conservation, and full use of men, machines and power units.

Size of operation is particularly significant. Enterprises too small to assure a profit are dropped and production is centered in larger-scale units. The effect on buildings is the obvious one of larger size, more equipment, higher investment and increased emphasis on efficiency.

On the non-farm side, structural developments are influential in creating changes. Engineering design affords a more precise basis for making improvements. New materials are adapted for farm use or old materials are improved. Advances in manufacturing, fabrication, erection methods,

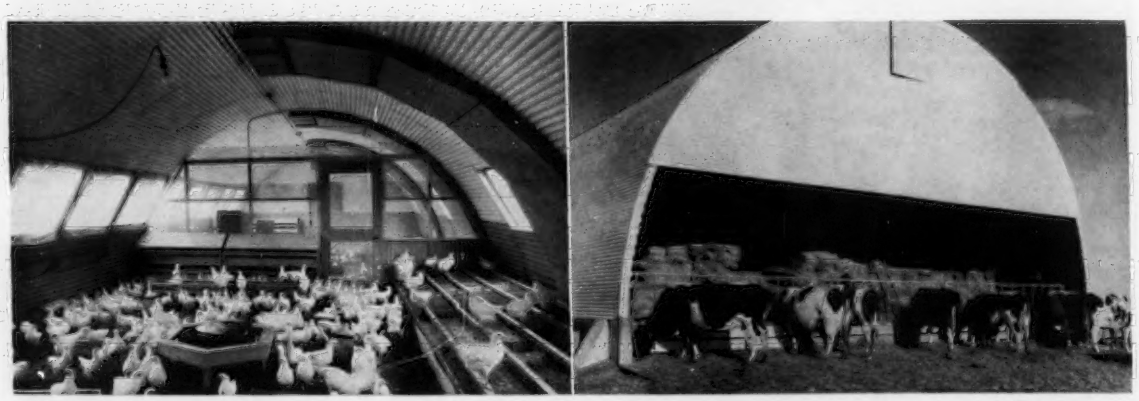


Fig. 3 Factory-made buildings are readily adapted to many farm uses by means of accessories and equipment (Great Lakes Steel Co.) • Fig. 4 Self-feeding, ground-level storage, prefabricated design and reduction of man labor are exemplified in this arrangement (Great Lakes Steel Co.)

Fig. 5 Tight metal bins on raised platform plus mechanized handling and sometimes artificial drying represent a typical trend in grain-producing areas (Butler Mfg. Co.) • Fig. 6 An example of post foundation steel frame with metal roofing and siding and a plan that facilitates machine methods (Butler Mfg. Co.)

and distribution give farmers a wider choice and better selection for meeting their building needs.

Other papers in this issue of AGRICULTURAL ENGINEERING feature various phases of farm-building development so that the summation that follows need not be detailed as to design and function. Rather, it lists the principal tendencies that have grown out of some 50 years of changing needs in production, management, and structure. Currently the trends are as follows:

*In structures,* greater utilization of
- Pole frames
- Trussed roofs
- Post-free interiors
- Metal sheets
- Plywood and composition sheets
- Concrete masonry units
- Prefabricated structural units
- Factory-built structures
- Contracted "package" buildings.

*In size,* a general increase in unit size for
- Poultry houses upward of 500-hen capacities
- Broiler houses often with facilities for 10,000 or more chicks
- Central farrowing houses with twenty or more stalls
- Movable hog houses of two to six-unit size in colonies
- Machinery storages often 36 to 50 ft wide, entrances up to 16 ft wide and 14 ft high, and any length desired
- Flat-type warehouse storage for grain, or multiple bins in a group
- Cattle and sheep-feeding layouts with yards, shelters and equipment for unlimited expansion.

*In equipment and facility for*
- Artificial drying of crops
- Automatic feed processing and handling
- Environmental control in buildings for poultry, hogs and dairy cattle
- Self-feeding of grain, forage and supplement to almost all classes of livestock
- Mechanized handling of such tasks as manure removal, yard cleaning, cattle feeding, milking, and conveying grain and forage.

*In building types toward*
- Elevated-stall milking rooms
- Loose housing for dairy cattle
- Fully equipped farm shops
- Tight-bin storage for corn
- One-story structures for all purposes
- Standard or adaptable designs for ready modification.

The foregoing list of trends, tendencies or practices applies most directly to the characteristic systems of farming that include both field crops and livestock. Some types of highly specialized production have gone even further in advanced construction, mechanization, economy and management. Examples are tobacco barns, caged-layer poultry houses, cattle-feeding centers, fruit and vegetable-processing facilities, and cereal-crop conditioning and storage buildings.

Although the most consideration has been given to service buildings, the farm home and its surroundings are certain to demand more attention in the future. Profits from farming should be translated into better living for the whole family.

With the coming of electricity to the farm, improvements in water supply, plumbing, heating and appliances, and availability of well-designed plans, the farmhouse may at least be the equal of the better houses in towns and cities. The investment in houses on farms is greater than the investment in all other farm buildings combined.

The farmstead, or farm headquarters, should also be given consideration and planned to conform to new needs and modern concepts of attractiveness and convenience. This means room for parking and turning, traffic on all-weather drives, access to most buildings by car, truck or tractor, an open service yard, suitable drainage, orientation to obtain sunlight, summer breeze, winter wind protection, and a harmonious composition of buildings and plantings.

The most obvious trend is that of continuing change. Today's recommendations will almost certainly be outmoded by future developments both in requirements and design. So it is most important to plan for the future. Agricultural engineers both in industry and public service are in a position to provide needed help. They are not only in touch with current events in their own profession, but they can draw upon the resources of state colleges of agriculture and the U.S. Department of Agriculture. And important contributions can be made by trade associations, manufacturers, management groups and distributors where products and services are utilized for farm-building improvement.

# Agricultural Processing — Past, Present and Future

**Carl W. Hall**
Member ASAE

AGRICULTURAL processing refers to those operations which aim at increasing the value of the raw farm product by maintaining or raising its quality in marketable yield, or changing its form or characteristics. Many of the technical societies use the term processing to include preservation only. However, as used in agricultural engineering, processing includes *preparation* for market, *preservation*, or *use* of the products. Names or designations which have been used by authors in articles published in AGRICULTURAL ENGINEERING to represent agricultural processing are manufacture of farm products, rural industry, agricultural industry, rural processing, farm processing, process engineering, agricultural process engineering, process industry, farm products processing, and agricultural product preparation. Some of these terms might describe more accurately the field of work included under agricultural processing but the word "processing" has been so ingrained in thought and usage that it has been accepted by the ASAE.

The first effort in the direction of agricultural processing by ASAE is reported in the *Transactions of ASAE* by the committee on the Manufacture of Farm Products. (2)* The committee listed the following advantages of carrying on certain manufacturing processes on the farm: *(a)* products may be used which are now wasted or lost due to small size or poor quality, over-ripeness, discoloration, lack of cars for shipping, or glutted markets; *(b)* the modern farmer now manages an enterprise which requires considerable executive ability. He is perfectly able to handle the additional problems attached to the various manufacturing processes; *(c)* labor, power and housing are often available and not efficiently utilized during the period which would be devoted to the manufacturing; *(d)* the majority of farmers are able to finance the manufacturing enterprise since their investment in land, etc. gives them a good credit basis; *(e)* by preparing the raw materials for use, they are often changed from an unstable product to a stable commodity which can be stored. This will allow holding and will strengthen the market. Loans on finished products may be made in many cases.

Following the committee report, the first major article pertaining to the manufacture of farm products reported by ASAE was on dehydration. Volume 18 of the *Transactions of ASAE* listed several manufacturing processes carried out in various states covering such subjects as canning of meats, fruits, and vegetables; curing of tobacco; small saw mills; making of cider; buttermaking; manufacture of maple syrup, and operation of grist mills (3).

The first article on grain storage and drying was published in the *Transactions of ASAE* in 1926, (9) and in 1928, a list of 100 problems in dairy machinery design was published. Many of the problems have been solved but there are still many similar problems today. From the very beginning of the Society, articles on subjects of agricultural processing were published. In Table I are listed the articles which appeared in the *Transactions of ASAE*, beginning in 1906, and in AGRICULTURAL ENGINEERING, beginning in 1920. These articles were listed on the basis of subjects included under processing in the *Agricultural Index* and does not include editorials or those articles devoted to subjects specifically included in the activities of other divisions, such as storage design. When drying was discussed in connection with storage, the article was listed in the table.

*Numbers in parentheses refer to appended references.

Paper prepared especially for the Golden Anniversary issue of AGRICULTURAL ENGINEERING.

The author—CARL W. HALL—is professor of agricultural engineering, Michigan State University, and chairman of the ASAE Committee on Agricultural Processing.

Fig. 1 *(Left)* Tunnel type prune dryers designed for on-the-farm dehydration of prunes (California)

Fig. 2 *(Right)* Farm type egg coolers permit immediate cooling of gathered eggs and holding in refrigerated rooms. Premium prices are then available to the farmers (California)

Even in the early years of the Society, from 1920-1924, there were 12 articles on processing and the number has increased over the past 37 years with 507 articles related to processing appearing in AGRICULTURAL ENGINEERING—an average of approximately one article per month over the period. The administration of the publication cannot be criticized for not lending its support and vision to the field. Repeatedly, editorials presented the possibilities of processing to its readers, even at a time when the subject matter was not as clearly defined as now. (10, 11, 12).

The real impetus for the development of agricultural processing came with the establishment of the rural electric division in 1925. Electric power and processing made a natural combination because electricity could be adapted to power and/or control of most processing operations. Electrification did much to provide means for preparing agricultural products, and the job is far from finished. It is true that the job of getting electricity to each farm is nearly completed but a tremendous job remains in using electricity —much for processing and many other possibilities in non-processing uses such as lighting, pumping, heating, etc.

After electricity was made available to each farmer, one of the most important contributions of agricultural engineers was the use of mechanical refrigeration for applications such as freezing fruits and vegetables, cooling of dairy products, cooling of eggs, freezing of milk, and, in the future, to provide the proper temperature for the greatest response of animals and plants.

The U.S. Dept. of Agriculture established a section in the Agricultural Engineering Research Division called mechanical processing, on a par with the farm structures, rural electric, and power and machinery areas. The mechanical processing section had its beginning in 1930 with the development of a major cotton ginning laboratory. Research along this line is being carried out today in the mechanical preparation and conditioning section of AERD, USDA.

Summarizing the activities in the field of dairy engineering in 1931 (1), the following immediate problems were presented: *(a)* improved quality, *(b)* reduction in cost of product, *(c)* improved transportation. Since then great strides have been made but there is still considerable work to be done, especially for improving methods of sterilization to provide a canned product which will keep when not refrigerated and which can be distributed any place in the world. Also, improvement of distribution of dairy and other food products is needed.

Although the work in agricultural processing hasn't been recognized nationally, work along these lines has not been neglected. The other ASAE divisions have done the work—perhaps at the expense of their own subject matter interest. Within a three-year period comprehensive national programs on grain drying were presented at separate annual meetings of ASAE by the farm structures, rural electric, and power and machinery divisions.

Fig. 3 *(Top)* Specific gravity separator for potatoes. The heavy potatoes are removed and used for improved potato chips and baking potato; light potatoes for boiling and frying (Michigan) • Fig. 4 *(Bottom)* Equipment for handling and grading apples with a minimum of bruising (USDA–Michigan)

TABLE I. ARTICLES APPEARING IN TRANSACTIONS OF ASAE AND AGRICULTURAL ENGINEERING PERTAINING TO PROCESSING (1906-1956)

| Subject | Trans. ASAE 1-29 | Volumes — AGRICULTURAL ENGINEERING 1-5 | 6-10 | 11-15 | 16-20 | 21-25 | 26-30 | 31-35 | 36,37 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Canning | | | | | | | | 1 | | 1 |
| Cotton gins and ginning | 2 | | 1 | 3 | 1 | 1 | 4 | | | 10 |
| Dairy farm milk equipment | 1 | | 6 | 11 | 6 | 4 | 6 | 5 | 1 | 39 |
| Dairy plant and equipment | 3 | | 9 | 14 | 4 | 3 | | 4 | 1 | 35 |
| Feed mills, grinders, etc. | 6 | | 5 | 7 | 4 | 2 | 1 | 5 | 3 | 27 |
| Food preservation (refrigeration, dehydration, radiation) | | | | 2 | 4 | 14 | 9 | 3 | 1 | 33 |
| Fruit handling, storage | 4 | | 6 | | 4 | | | 6 | 3 | 19 |
| Grain-handling and drying | 6 | 3 | 11 | 5 | 8 | 11 | 19 | 23 | 7 | 87 |
| Hay-handling and drying | 6 | | 8 | 19 | 17 | 15 | 55 | 15 | | 129 |
| Poultry and eggs | | | | 1 | | 1 | 2 | | | 4 |
| Rice-handling and drying | 1 | | | 4 | | 2 | 2 | 4 | 1 | 13 |
| Root crops | | 1 | 1 | 4 | 2 | 5 | 1 | 3 | | 17 |
| Seeds, small | | 1 | | | | 2 | 2 | | | 5 |
| Silage | | 2 | 2 | 4 | 6 | 6 | | 3 | 2 | 25 |
| Slaughtering | | | | 1 | | | | | | 1 |
| Tobacco—handling & curing | | 1 | | | | 1 | 1 | 1 | 1 | 5 |
| Waste products and crop residues | | | 1 | 2 | 1 | 8 | 4 | | | 16 |
| Wood industries | 1 | 3 | 1 | 1 | | | 3 | 1 | | 9 |
| Other | | | 1 | | 2 | 5 | 3 | 12 | | 23 |
| General processing | 2 | 1 | | | 1 | 1 | 2 | 2 | 2 | 9 |
| Total | 32* | 12 | 52 | 78 | 60 | 81 | 114 | 88 | 22† | 507‡ |

*Transactions ASAE*, vol. 1, 1906; vol. 29, 1935
AGRICULTURAL ENGINEERING, vol. 1, 1920; vol. 37, 1956
*Some of the articles in the *Transactions* also appeared in AGRICULTURAL ENGINEERING
†Represents two years only
‡Articles in AGRICULTURAL ENGINEERING only.

## . . . Agricultural Processing

Fig. 5 A beta ray accelerator used for treating various agricultural products. Sprouting of potatoes can be prevented, insects sterilized or killed, products sterilized (Michigan)

Fig. 6 Cherries being handed in bulk in water. Here cherries are being moved from tanker to processing plant. Decreased cost results and on-the-tree quality is maintained (USDA)

Fig. 7 Sorting of red tart cherries. Agricultural engineers developed basic data on lighting to enhance undesirable spots on cherries and thereby improve sorting efficiency (Michigan)

The processing activities of ASAE members have been concentrated principally in grain and hay drying. Grain drying has grown considerably, perhaps due to the pressure of the production machinery developments. Hay drying had a rapid growth shortly after World War II, but has not made the rapid gains which drying can justify. The dairy industry has received some attention. Dairy products form the principal livestock income to U.S. farmers but practically all of the basic work was reported by a few men about 1930. Considerable progress has taken place since then but AGRICULTURAL ENGINEERING has not been the outlet for the published information. Many articles have been published in other periodicals and technical journals with agricultural engineers as authors or co-authors, which indicates the interest and activity of the membership in these subjects. One ASAE member interested in the field of agricultural processing has stated that he wrote thirty articles in other publications to each article he published in AGRICULTURAL ENGINEERING. Work on mint distillation; hybrid corn; small seeds; fruit harvesting, handling, storing and packing; abattoirs; processing of special fibers; citrus handling; canning; etc. are of such specialized local interest in many cases that publication in AGRICULTURAL ENGINEERING would not be warranted unless new basic data were obtained or a unique technique developed (such as electronic lemon sorting) which is of widespread interest and applicable to many products. However, by providing distribution through ASAE papers and carrying an abstract of the paper and paper number in the Journal, material can be brought to the attention of the membership without publication of the entire paper. In April, 1954, the order of interest in processing according to projects in agricultural engineering departments in the United States was as follows: Crop drying and/or storage—56 projects; vegetable and fruit harvesting aids—25; materials handling—25; canning—19; dairy products research—19; food freezing and cold storage—16; yet the publication of papers on most of these subjects with the exception of drying in AGRICULTURAL ENGINEERING has been rather limited (12).

The term "agricultural processing" first appeared in the index of AGRICULTURAL ENGINEERING in 1930. It was 1948 before the *Agricultural Index* first used the designation "agricultural products—processing". The *Bibliography of Agriculture* (USDA library) included a section in Vol.

2 of No. 1, January, 1943, under the heading "food processing and distribution." In another section, under Agricultural Engineering — Farm Machinery, the sub-heading "harvesting, threshing, drying and processing equipment" is used. In January, 1947, a separate heading was used, probably because of the increased activity in processing, as follows: "processing equipment used on the farm".

There are many reasons for the increased interest in processing. Several changes have taken place in agriculture during and following World War II, such as: farms have become larger and more efficient, have more competition for manpower with industrial labor, used more fertilizer, and obtained higher crop yields. There have been more products to handle per man-hour and considerable products stored on the farm. Small bins and bag storage have been replaced by bulk storage. With new varieties the area in which certain crops are grown has spread. Centers of population have increased in size. Just as the size of farms has increased so has the size of retail markets grown and the number of major super market chains has decreased. The buyers want to purchase large quantities of uniform products on a year-round basis (4).

Only recently have state governments backed the development of programs devoted to the distribution and utilization of agricultural products. Research agencies of the federal government recognized this vast field of endeavor through the establishment of the USDA regional utilization laboratories. The first major interest in marketing was the Research Marketing Act in 1946 whereby funds were made available to state and federal agencies for work in this field. In 1953 through the recent reorganization of the USDA emphasis was placed on marketing by establishing the Agricultural Marketing Service. Several of its units, principally the Transportation and Facilities Branch and the Biological Sciences Branch, hire the services of many agricultural engineers.

Agricultural processing was not recognized by ASAE as a major field of divisional activity until 1956 when the Division of Electric Power and Processing was established by action of the Council at the December meeting in Chicago, Ill.

Many people have suggested that the field of agricultural processing as covered in ASAE should be confined to farm applications. This is not a logical procedure. For some agricultural engineering departments, company research groups, and for federal research purposes, this might be a pertinent procedure with respect to funds. However, ASAE members should be interested in agriculture in its broadest aspects and interested in all phases of agricultural processing whether on or off the farm. For ASAE to restrict agricultural processing to the farm applications would be as logical as the limiting of the agricultural engineer's interest in farm tractors to their use on the farm and not to the design, development and testing as now done. Processing on or off the farm is basically the same except for the size of equipment. Whether the processing operation is carried out on or off the farm is based primarily on economics—today it may be on the farm and tomorrow it may be off the farm or vice-versa. At first thought, one might think that processing would move away from the farm. This thought is based on increased specialization of agriculture as an in-

Fig. 8 K. H. Norris, agricultural engineer, USDA, operating the Green-Rot Detector, a practical application of the technique for measuring the spectral characteristics of unbroken eggs. The detector automatically separates eggs containing green-rot bacterial infection from good eggs (USDA—Beltsville, Md.)

Fig. 9 A poultry picker developed for the small operations of poultry processing. It can be built from inexpensive readily available materials (USDA)

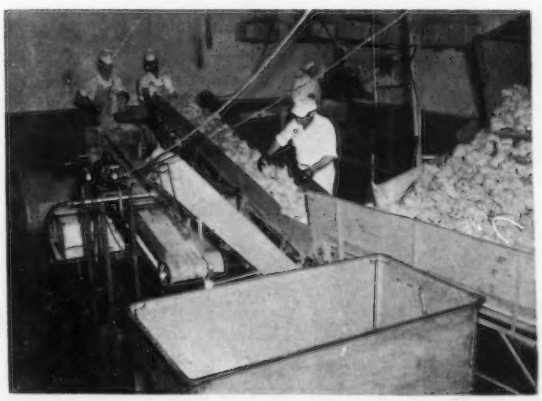


Fig. 10 An integrated poultry packing line reduced the time requirements and speeded production. Two packers can process more than 5000 birds per hour (Georgia and USDA)

## . . . Agricultural Processing

Fig. 11 A mobile fruit cooler, cooled by ice permits the field heat to be removed immediately. This permits prime quality fruit to be delivered with appropriate price increase reflected for the farmer (California)

Fig. 12 Storage studies utilizing crates of apples on pallets and covered with a plastic film. The objective is to improve storage quality

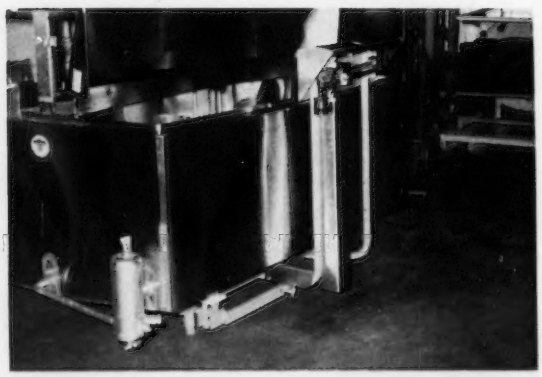


Fig. 13 Research on accuracy of using scales for determining the quantity of milk in bulk cooler. There are now nearly 70,000 tanks in the United States, of which the majority have been installed in the last 5 years

dustry. But by carrying this specialization to the extreme, say on a product basis, would mean not only specializing in *production* but *preparation* of an agricultural product for further *processing* or use, thus raising the value of the product. It might involve more farm processing than is done now. The producer has the first choice in utilizing his product.

In a major effort to define the scope and determine the extent of work by ASAE members, the Committee on Agricultural Processing was formed in 1949. Several technical programs were sponsored by the committee from 1949 to 1956 covering such subjects as materials handling, new developments in storages, seed cleaning, cotton processing, cathode and beta ray treatment, etc.

The offering of courses in processing in colleges has increased rapidly until at the present time the majority of agricultural engineering curriculums contain one or more courses. A technical textbook has done much to advance the training of engineers in processing (6). Just as the research work has been done by the other divisions, so some of the material included in agricultural processing has been covered in courses in machinery, electricity or structures. The basic principles involved in teaching agricultural processing deal with biological properties and unit operations, principally heat transfer and fluid flow and materials handling. These subjects are not normally considered as congruent. Those who normally specialize in one of these areas would not normally specialize in the other, and therefor special training is involved for agricultural processing. Special laboratory facilities and personnel are needed to properly teach courses in processing. Because of the broad aspects of the field, most of the training specifically in processing has been obtained on a graduate engineering level.

The greatest progress in teaching and research is accomplished by team effort working with commodity groups—crops, dairy, poultry, horticulture, etc. Cooperation from machinery, structures, and electric power will be required to properly set up processing courses. In addition, there is considerable demand for service courses, particularly by agricultural education and extension majors. These offer a great opportunity for providing other professions with valuable subject matter. A new vocabulary is required for those interested in agricultural processing such as enzymes, antibiotics, systemic, rep, organoleptic, biological-oxygen-demand, no-hold pasteurization, cold sterilization, controlled atmosphere, free radical interceptor, anti-oxidant, etc.

The job opportunities are many and varied. Industry, government and education offer jobs on all levels. Many have assumed important positions in management. To maintain the interest of organizations which hire men in processing, graduates must be properly trained. The future of agricultural processing involves a great and interesting challenge.

Looking to the future:

- It is important to recognize that conditions change and items formerly considered limiting factors may not be so important. For example, the use of certain agricultural products for industrial uses becomes more practicable as the industrial products formerly used become more expensive.
- When one limiting factor is overcome, there are others which become limiting and require investigation. Research in agriculture is dynamic and there is no end to the problems.
- Changing the method of processing or developing a new process may change the whole production method or might be incorporated as a part of the production machinery.

- New developments usually involve working with the users of equipment, the state and federal agencies, and regulatory groups. Ten years ago the use of cleaning-in-place of dairy piping on the farm was considered very unlikely, but today it is considered as a better procedure than the old method of dismantling the line and washing it each day. CIP has developed through the cooperation of all involved.
- Much basic knowledge is needed on agricultural products. Just as we have steel, concrete, wood and metal handbooks, so we need handbooks on the properties of agricultural products. With these properties, we can design better production and processing equipment.
- More automatic controls will be used and there will be many operations which will be completely controlled. At present, most of the work is devoted to development of components which later can be fitted into an over-all process. With the development of more controls and continuous processing, equipment will be designed to operate through a 24-hour day, seven-day a week basis, rather than having equipment large enough to carry out the operation in only an hour or so per day.
- Machinery for small scale operations should not be overlooked, particularly as new materials, controls and methods become available.
- An improvement in labor efficiency must result with newly developed methods and equipment.
- Improvement of pasteurization methods and equipment and procedures for sterilization offer considerable possibilities. The use of various types of radiation will be investigated further. Application looks particularly promising for treatment of grains, fruits, and vegetables.
- There will be more use of electronic equipment for such operations as grading and quality measurement and control.
- Considerable information and data are available on drying but a unified theory of drying remains to be developed.
- Improved harvesting and handling methods for fruits and vegetables are needed.
- New materials will be developed and used for structural members and for food product contact surfaces.

## Summary

Agricultural processing activities have been a part of the subject matter interest of ASAE and its members since the 1920's. The impetus to development of processing activities came from extension of electric power to farms and the emphasis on research in this field started in the USDA with the cotton ginning studies. Research programs have been in effect for many years. Teaching programs are now in the development stage at most institutions. The number of colleges with adequate staff and facilities for teaching processing is limited. Those individuals going into industry in processing work must be specially trained, or the demand will not be maintained. Many have received special training through experience and graduate work. Active interest in processing has been maintained by Society committees, culminating with the formation of the Electric Power and Processing Division in the beginning of the Society's 50th year.

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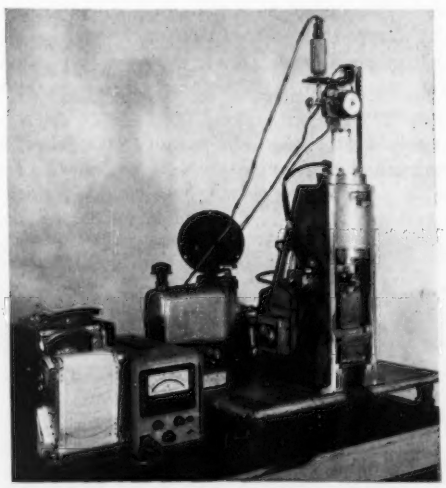

Fig. 14 The recording Shear-Press, an instrument for measurement of rheological properties of agricultural products. Picture shows force measuring and recording instruments used with press (USDA—Beltsville, Md.)

Fig. 15 Gerald S. Birth, agricultural engineer, USDA, operates the Rephobiospect, an instrument for recording the spectral transmittance curves of intact agricultural products. This technique is being used to evaluate the interior flesh color of fruit and vegetables and to detect the presence of certain defects in agricultural products (USDA—Beltsville, Md.)

# Rural Electrification Since the Turn of the Century

**J. P. Schaenzer**
Fellow ASAE

WHEN reflecting upon the history of rural electrification it unravels like a legend in "make believe." It is so young, so short a time since its birth, yet so much has happened which affects the lives and habits of all of us. The rapid growth and progress is due to the effort put into the program by the thousands of people who have given their lives to this work. The accomplishments and changes which have taken place through the past half century in home making and farming are amazing.

Group action was also a potent factor through the years. Farmer organizations, government, electric power companies, rural electric cooperatives, manufacturers, bankers and many others invested billions of dollars to bring electric service to rural America.

Even with the many years of background experience, and the time spent on research for this article there may be omissions. Space limitations also are a handicap. So many fine men and women have dedicated their lives to this cause and have done so much individually and collectively to bring their dreams to fruition. Some of their names and accomplishments may have been missed in this short resume. This is regretted. Let's hope that someone in the near future will have the initiative and courage to write a complete history. It should be done.

The most important facet in this development and progress was the farmer and his wife. They wanted electricity —they needed it both in the home and for doing chores; they knew that it could relieve them of some of the heavier burdens of labor; they realized that it could help to make farming more profitable; and they hoped that it would bring more leisure, comfort and a better home life. All of these came to pass and more.

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Some 25 years ago Cornell University (1)* found that 40 days of labor per farm per year could be saved by the proper application of electricity. Similarly 26 days could be saved in the home. About 30 years ago the University of Wisconsin (2) studied the use of electric light vs the lantern for doing chores. Electric light for stabling the cows, cleaning the mangers, and feeding took 55 minutes as compared with 85 before. Farmers reported that good light saved them one hour per day for each man. At that time the benefits of electric service were well expressed by M. C. Albright, in a radio broadcast. He said that since replacing muscles with electric energy we find less need for rest, and have more time for recreation, and the children have more time for study, 4-H and play. The wife's work is done quicker and easier and leaves her fit for growing flowers and playing bridge. As for himself he said that he has more time for community activities, to enjoy the youngsters, play barnyard golf or go fishing or hunting. He believed that electricity is a real and proven farm relief.

Compare these statements with the progress and changes that have resulted from today's electric mechanization of farming enterprises. Those were good days, but now they are better by far. A few cases point this out. Last fall a few farms were visited in Pennsylvania. On a dairy farm two women fed concentrates and milked 60 cows in a milking parlor in 1½ hours. The pipe line milker was washed in place. When the milking was done the milk was in the bulk milk tank and partially cooled.

On another farm one man during the winter cared for 275 beef cattle and 90 hogs (Fig. 2). It was easy. A silo unloader dropped silage on a mechanical feeder which delivered it to the animals. Enroute a pump on a 4000 gal tank put molasses on it. Water bowls furnished the water. The hogs were self-fed.

The third farm produces broilers in 20,000 lots (Fig. 2). The poultry house is equipped with automatic waterers, two mechanical feeders and electric heat lamp brooders. The owner said that it took him three hours a day to take care of the birds.

## Commercial Generation Beginnings

Electricity as a source of light, heat and power has been available to man for a relatively short time. On September 4, 1882 the first central, steam-operated, electric generating station in the world was opened in New York City by Thomas A. Edison. Under the name of Pearl Street Station it furnished light to 59 customers.

The first hydroelectric central station was placed in operation at Appleton, Wis., on October 15, 1882, with a capacity of 250 incandescent lamps.

*Numbers in parentheses refer to the appended references.

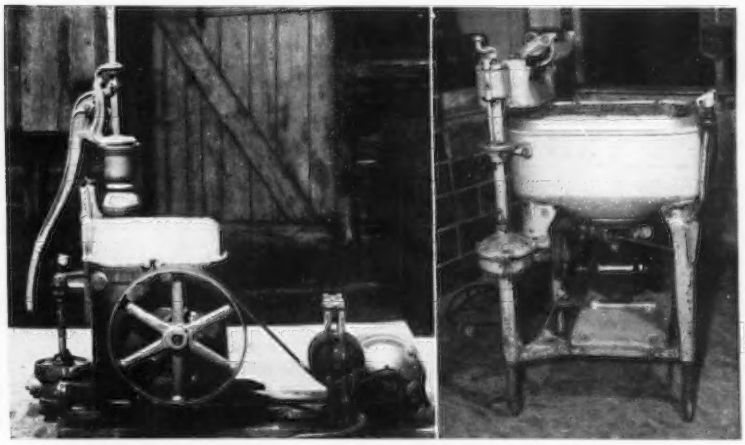

Fig. 1 Early farm conversions to electricity included *(left)* deep well pump outfit, Montgomery County, Md. *(right)* washing machine

**Electric Service Goes to Farms**

From this meager beginning, a few farms were electrified by 1898. In a letter W. G. Vincent (3) wrote about an electric pump installation for irrigation on a farm near Mayhews, Calif. Gas engines were replaced. Another farm near Yuba City was connected April 28, 1898. A 5-hp motor drove a line shaft which operated a raisin stemmer and cider press, pumped water to an overhead tank and irrigated 25 acres. There were only 350,000 customers for electricity at the turn of the century, yet surprisingly a few farms had electric service.

Also in 1898, Guy R. Beardslee (4) built a 180-kw power plant on East Canada Creek, near St. Johnsville, N. Y. Two years later a mill owner two miles up stream asked for power. Beardslee, having an eye for business, built the line along a highway of prosperous farmers rather than cross country although it was twice as far. One farmer, Charles Cook, took the service and it was the first farm line extension in New York. He made a substantial investment in a motor, wire, transformer, meter and other equipment at the barn. In 1903 another, Clarence Timmerman, connected and used an electric motor to fill his silo.

The Pacific Power and Light Company (5) built its first rural extension in 1906 to farms in Hood River County, Ore. The farms were owned by James M. Hamblett, W. J. Baker, A. C. Hershey, W. H. Paugh and E. H. Sheppard. Mr. Sheppard used a ¼-hp motor on the first apple grader in the area. Thirty years later 950 farms, 84 percent, in the county had electric service. That is progress.

Senator Joseph C. O'Mahoney (6) prepared an article entitled "One Hundred Years Hence" for *Sunday Magazine*, October 21, 1906. He wrote: "The application of electricity to agriculture will make the farming of the future more productive, more remunerative and more pleasant. Stations scattered throughout the country will furnish power to all farms in the neighborhood . . . . . Cutting, churning, grinding, pumping, threshing and all other farming activities will depend almost absolutely upon electricity . . . . . Electric lights of great brilliance will make night work as convenient as work by day." These and more were predicted in 1906.

As time went on a few farms were equipped for electric service in all sections of the country. It was slow. The larger cities were first. In 1923 a survey (7) showed that 62 towns with more than 2500 people and 7940 communities of 250 to 2500 had no electric service. Generating stations were small. Long distance transmission was not known. Many plants operated only at night and later during the day for washing and ironing only. It seemed natural that the farmer, with long distances between him and the labor for construction, and the accompanying cost of line equipment, should be last. But—let's see what happened.

The first government statistics (8) showed 100,000 farms electrified, December 31, 1919, and the Bureau of the Census 6,448,343 farms. The electrified farms were highly concentrated in California and irrigated areas.

Fig. 2 Present applications of electricity have lightened the load of farmers. *(Left)* poultry-man cares for 20,000 chicks, 3 hours daily, with brooders, automatic waterers and mechanical feeders; (center) pumping molasses from a 4000-gal tank on silage as it passes on mechanical feeder; and *(right)* one man cares for 275 beef cattle with mechanical feeder and silo unloader

| Kinds of Power on Farms | HORSES, MULES, OXEN | GAS TRACTORS | | STEAM DRIVEN TRACTORS | GASOLENE MOTOR TRUCKS | STATIONARY ENGINES | | WIND-MILLS | INDIVIDUAL ELECTRIC PLANTS | PURCHASED ELECTRICITY | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Power From Belt | Power For Pulling | | | Over 5 H.P. | 5 H.P. or Less | | | From Small Electric Cos. | From Large Electric Cos. |
| Number Used | 20,770,000 | 400,000 | | 50,000 | 356,000 | 20,000 | 2,480,000 | 1,000,000 | 300,000 | 200,000 Installations | 20,000 Installations |
| Total Horse Power of Each Kind | 19,800,000 H.P. | 8,000,000 H.P. | 4,000,000 H.P. | 2,500,000 H.P. | 7,120,000 H.P. | 500,000 H.P. | 6,800,000 H.P. | 500,000 H.P. | 900,000 H.P. | 800,000 H.P. | 500,000 H.P. |
| Work Done Yearly by Each Kind of Power | 9,700,000,000 H.P. Hours | 700,000,000 H.P. Hours | 900,000,000 H.P. Hours | 1,000,000,000 H.P. Hours | 600,000,000 H.P. Hours | 500,000,000 H.P. Hours | 1,500,000,000 H.P. Hours | 200,000,000 H.P. Hours | 150,000,000 H.P. Hours (Input Only) | 150,000,000 H.P. Hours | 600,000,000 H.P. Hours |
| Cost of 1 Hours Work of 1 H.P. of Each Kind | 25¢ | 6¢ | 12-1/2¢ | 6¢ | 20¢ | 4¢ | 8¢ | 5¢ | 25¢ | 15¢ | 5¢ |

Fig. 3 An appraisal of power used on farms in the United States (Bulletin No. 1348, USDA, February, 1926)

## . . . Rural Electrification

### National Electric Light Association Activities

In 1910 the National Electric Light Association (Nela) named the first committee on electricity in rural districts with John G. Learned as chairman. A year later the committee submitted a printed report (9) of 84 pages. Other reports followed the next two years. Twenty-two states were listed as having electrified farms and 100 different applications. The committee urged that the U.S. Department of Agriculture get out a bulletin on the use of electricity on the farm and two were published (10). It also recommended that farm machinery be adapted to electric motor drive and that an expert be employed to prepare popular articles for publication in rural papers.

To further study, investigate and make recommendations for the solution of problems in rendering electric service to the farmer the rural lines committee (11) was set up in 1921. A first survey showed 177,561 electrified farms for December 31, 1923. Later, surveys were taken over by the association. See Table 1.

### Committee on the Relation of Electricity to Agriculture Organized

It became more and more evident that many farmers wanted and needed electric service to help with the farm work and also relieve the homemaker of the more difficult housework. With this in mind representatives of Nela and American Farm Bureau Federation organized CREA in August, 1923, with E. A. White, director, Chicago, Ill. In accepting this position he remarked, (12) "As the farmer looks over the fence into the electrical field he feels that he must have this service . . . . . The increasing demand for electric service by the farmer has developed without sales effort on the part of central station companies. In fact, these companies have generally discouraged farmers who attempted to secure this service because the revenue obtained has not been sufficient to meet the expense of rendering it. . . . Can means be found which will place this service on a sound economic basis?

"Beyond these problems is the greater one of building an American civilization. Neither maximum agricultural or national development can be expected unless the people of the open country have as good living conditions as urban dwellers of comparable economic standing."

Dr. White's objective was to give purpose and direction to the work to determine the maximum economic uses for electricity in agriculture and the home. Investigations were initiated on existing farm practices and a search for new methods began. Equipment needed adaptation. The results obtained were made available to anyone.

The original 13-member committee represented the following organizations:

American Farm Bureau Federation
American Society of Agricultural Engineers
National Electric Light Association
Power Farming Association
U.S. Department of Agriculture
U.S. Department of Commerce
U.S. Department of Interior

Through the years a number of others joined the committee while several dropped out.

The U.S. Department of Agriculture under the direction of S. H. McCrory, agreed to collect, digest and make available to the public all information on farm power. An

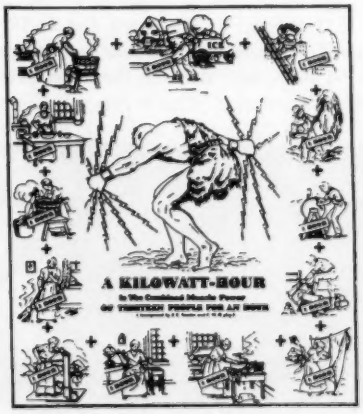


Fig. 4 Artist's picture of a kilowatt-hour, showing that it equals the muscle power of 13 men for an hour all combined (February issue, 1934, of G. E. Monogram)

exhaustive survey was made and published (13). See silhouette chart (Fig. 3). This was followed by another (14) in April, 1933. In part, the authors wrote, "Use of electricity on farms in the United States has increased during the last few years in spite of the general depression in agriculture."

The federal office of experiment stations undertook the direction of the development of a research program. On June 27, 1924, R. W. Trullinger, then specialist in rural engineering, speaking before the annual meeting of the American Society of Agricultural Engineers (15) stated, "It seems evident that the rational application of electricity to agriculture will require, *(a)* a large amount of fundamental agricultural and engineering research to provide the backbone of the movement, and *(b)* a certain but gradually increasing amount of investigational work to determine power requirements and exact electrical applications." Six years later, at a similar convention (16) Dr. Trullinger reported 32 active research projects in rural electrification among 17 stations. Through the years the number has been both up and down, with many directly or indirectly related to the subject. Since July, 1945, B. C. Reynolds has been in charge of this activity.

In addition, where sufficient interest was found Dr. E. A.

TABLE 1. FARMS SERVED ON POWER LINES IN THE UNITED STATES
By Type of Utility Serving the Farm

| Date | Investor-owned | REA cooperatives* | Government† | Farms served | Number of farms‡ | Percent Connected |
|---|---|---|---|---|---|---|
| December 31, 1955 | 1,940,000 | 2,287,000 | 260,000 | 4,487,000 | —— | — |
| December 31, 1954 | —— | —— | —— | 4,421,000§ | 4,782,393 | 92.4§ |
| December 31, 1953 | 2,158,000 | 2,544,000 | 290,000 | 4,992,000 | —— | — |
| December 31, 1952 | 2,117,000 | 2,475,000 | 282,000 | 4,874,000 | —— | — |
| December 31, 1951 | 2,069,000 | 2,318,000 | 267,000 | 4,654,000 | —— | — |
| December 31, 1950 | 1,998,000 | 2,168,000 | 258,000 | 4,424,000 | —— | — |
| April 1, 1950 | 1,912,693 | 1,998,000 | 246,000 | 4,156,693 | 5,382,162 | 77.2 |
| | | *Old Classification of U.S. Census‖* | | | | |
| December 31, 1949 | 2,407,046 | 2,343,738 | 243,916 | 4,994,700 | —— | — |
| December 31, 1948 | 2,250,595 | 1,921,160 | 216,445 | 4,388,200 | —— | — |
| December 31, 1947 | 2,082,316 | 1,533,894 | 200,890 | 3,817,100 | —— | — |
| December 31, 1946 | 1,883,649 | 1,260,516 | 191,535 | 3,335,700 | —— | — |
| December 31, 1945 | 1,707,100 | 1,051,000 | 170,900 | 2,929,000 | —— | — |
| December 31, 1944 | 1,556,243 | 914,557 | 159,000 | 2,629,800 | 5,859,169 | 44.9 |
| December 31, 1943 | 1,520,368 | 813,632 | 141,000 | 2,475,000 | —— | — |
| December 31, 1942 | 1,502,537 | 772,463 | 125,000 | 2,400,000 | —— | — |
| December 31, 1941 | 1,489,246 | 696,754 | 110,000 | 2,296,000 | —— | — |
| December 31, 1940 | 1,448,500 | 517,500 | 84,000 | 2,050,000 | —— | — |
| April 1, 1940 | —— | —— | —— | 1,853,249 | 6,096,799 | 30.4 |
| December 31, 1939 | 1,348,500 | 333,500 | 82,000 | 1,764,000 | —— | — |
| December 31, 1938 | 1,174,500 | 150,000 | 82,000 | 1,406,500 | —— | — |
| December 31, 1937 | 1,093,400 | 40,000 | 82,000 | 1,241,505 | —— | — |
| December 31, 1936 | 976,350 | 6,500 | 60,000 | 1,042,924 | —— | — |
| December 31, 1935 | —— | —— | —— | 788,800 | —— | — |
| December 31, 1934 | —— | —— | —— | 743,950 | 6,812,350 | 10.9 |
| December 31, 1933 | —— | —— | —— | 713,558 | —— | — |
| December 31, 1932 | —— | —— | —— | 709,449 | —— | — |
| December 31, 1931 | —— | —— | —— | 698,786 | —— | — |
| December 31, 1930 | —— | —— | —— | 649,900 | —— | — |
| April 1, 1930 | —— | —— | —— | 596,014 | 6,288,648 | 9.5 |
| December 31, 1929 | —— | —— | —— | 576,168 | —— | — |
| December 31, 1928 | —— | —— | —— | 506,242 | —— | — |
| December 31, 1927 | —— | —— | —— | 393,221 | —— | — |
| December 31, 1926 | —— | —— | —— | 309,125 | —— | — |
| December 31, 1925 | —— | —— | —— | 246,150 | —— | — |
| December 31, 1924 | —— | —— | —— | 204,780 | 6,371,640 | 3.2 |
| December 31, 1923 | —— | —— | —— | 177,561 | —— | — |
| December 31, 1919 | —— | —— | —— | 100,000¶ | 6,448,348 | 1.6 |

*REA figures represent cooperatives only, and exclude customers of all other agencies (companies and municipals) financed in whole or in part by REA.

§Does not include an estimated 27,500 farms served by home lighting plants.

†Customers served by municipal systems, and various power districts not financed by REA.

‡U.S. Census Old Farm Classification —"A farm is any tract of land of three or more acres used mainly to produce agricultural products, or any place of three acres or less, where the owner or tenant devotes his entire time thereon to agriculture, or the annual value of agricultural products exceeds $250. (Note: Poultry and game raising, floriculture and horticulture, and similar pursuits fall within this classification.)"

‖U.S. Census Farm Classification —"A farm is any place of three or more acres on which the value of agricultural products produced in 1949 amounted to $150 or more; also any place of less than three acres on which the value of agricultural products sold in 1949 amounted to $150 or more."

¶Estimated by Bureau of Public Roads, U.S. Department of Agriculture.

Source — Statistical Bulletins for the years 1946 and 1955. Edison Electric Institute, New York.

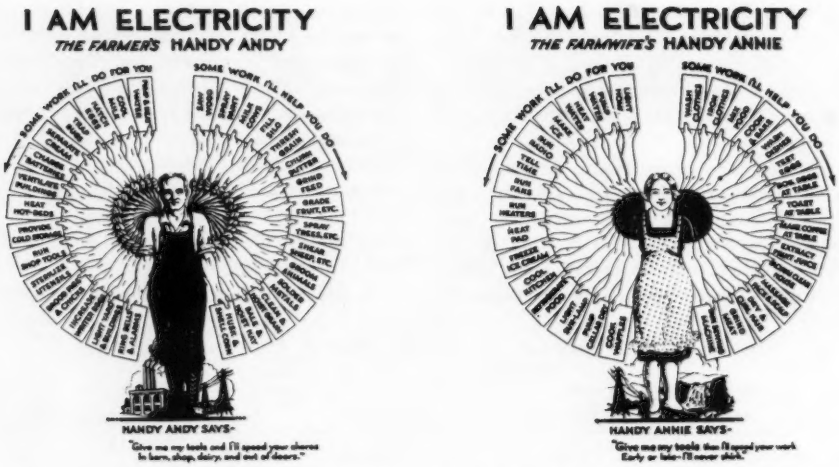
I AM ELECTRICITY
THE FARMER'S HANDY ANDY
SOME WORK I'LL DO FOR YOU
SOME WORK I'LL HELP YOU DO
HANDY ANDY SAYS-
I AM ELECTRICITY
THE FARMWIFE'S HANDY ANNIE
SOME WORK I'LL DO FOR YOU
SOME WORK I'LL HELP YOU DO
HANDY ANNIE SAYS-

Fig. 5 The versatility of electricity is illustrated by two pictures that personify electricity — Handy Andy and Handy Annie. Cartoon appeared in February issue, 1934, of G. E. Monogram

## . . Rural Electrification

White set up state committees similar in organization to the national. His office served as the coordinating influence. The first state CREA committee was organized in Minnesota in 1923. Nine farms were selected for electrification near Red Wing, and it was known as The Red Wing Project. The objectives were outlined by the division of agricultural engineering and agricultural experiment station to "determine the optimum economic uses of electricity in improved living conditions on farms." Electricity was turned on December 24, 1923. The project director was E. A. Stewart, agricultural engineer. The divisions of farm management and home economics cooperated. The "test line" was financed by the University of Minnesota, electric power companies, Minnesota CREA and 79 manufacturers of electric equipment. The farmers installed and paid for recommended wiring and water supply. The results of the five year test were published (17) in 1930.

Other state CREA committees were organized in 27 states in rapid succession, and full time project directors employed to develop comprehensive research projects at the colleges and establish experimental lines and test farms to secure practical operating experience.

Electric equipment for test and research purposes was furnished by 226 manufacturers (18). Also listed are 227 rural uses for electricity. This is well over 400 now.

The national committee met annually to coordinate the work until 1939 when it disbanded. Accomplishments and problems, both national and by states, were presented and plans laid for the future. The state committees operated similarly, but in addition many of them held rural electrification conferences or short courses open to all. Bulletins and progress reports were published. Among the project directors and engineers in the 1920's were: Nichols and Easter (Ala.); Fletcher, Moses, Wood and Tavernetti (Calif.); M. R. Lewis and Beresford (Idaho); Lehmann and Kingsley (Ill.); Hienton (Ind.); Paine and Zink (Iowa); Walker, Fenton, Logan and Hinrichs (Kan.); Doran (La.); Bissel, Moore, Musselman, and Gallagher (Mich.); Stewart, Larson, Boss and Romness (Minn.); Wooley, Parks and Jones (Mo.) Brackett and E. B. Lewis (Nebr.); Ackerman (N. H.); Oley (N. J.); Riley, Robb. Parrott, Fairbanks and Nixon (N. Y.); McCuen, Hess and Blauser (Ohio); Kurtz, Hazen and Naeter (Okla.); Kable, Gilmore, Price and Hurd (Ore.); McKee, Blasingame, and Nicholas (Pa.); McAlister (S. C.); Patty (S. D.); Scoates, Waggoner and Montfort (Texas); Sietz, Waller and Hillman (Va.); Smith and Garver (Wash.); Duffee, Meacham, Krueger and Schaenzer (Wis.).

CREA (national) published and distributed nearly one-half million bulletins, (19) circulars, news letters and handbooks. Considered the most valuable reference book at the time was the revised edition of Bulletin Vol. VII, No. 1, Electricity on the Farm and in Rural Communities, 8½ x 11 inches, 332 pages. Much of the assembling of the subject matter, editing and publishing was the responsibility of the three assistant directors. They were

Frank D. Paine—January, 1926 to December, 1926
Lee C. Prickett—March, 1927 to June, 1933
J. P. Schaenzer—April, 1936 to August, 1939

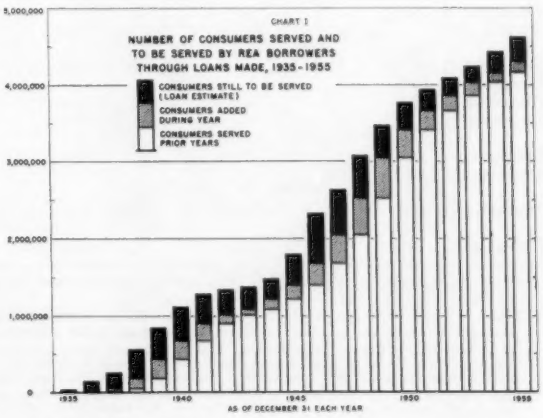


Fig. 6 Number of consumers served and to be served by REA borrowers through loans made, 1935 to 1955

### Farm Electric Lighting Plants

The Bureau of the Census in April, 1930, estimated that 250,000 individual lighting plants were in use on farms. For other years it was as high as 300,000. The Bureau also reported the sale of nearly one-half million units between 1919 and 1929. The number has been declining yearly with the coming of central station service. A book (20) of 265 pages was published in 1919 which dealt with light, heat, and power by inexpensive methods from the water wheel or farm engine. In the preface F. I. Anderson writes, "The tiny unconsidered brook that waters the farm pasture frequently possesses power enough to supply the farmstead with clean, cool, safe light in place of the dangerous inconvenient oil lamp; a small stream capable of developing from 25 to 50 hp will supply a farmer (at practically no expense beyond the original cost of installation) not only with light, but with power for even the heavier farm operations as threshing; and in addition will do the washing, ironing and cooking, and at the same time keep the house warm in the coldest weather."

### American Society of Agricultural Engineers Fills a Need

The Society through the Rural Electric Division has served as a catalyst in bringing together all rural electrification forces and in disseminating the findings among all groups. In its annual national and sectional meetings and through AGRICULTURAL ENGINEERING it enables teachers, researchers and extension workers of colleges and federal agencies to mingle and get acquainted with the power suppliers, manufacturers, and inventors in order to exchange ideas, and get a better understanding of mutual problems for a common solution. Much has been accomplished in preparing functional specifications for electric equipment, in speeding up basic research through discussing freely the results obtained, and applying this knowledge to the development and application of electric devices of economic help to the farmer in the production of food and fiber. Throughout this article you have recognized the names of many outstanding agricultural engineers and their participation in the rural electrification program to make it a national success. The members especially interested in this activity, through the efforts of E. A. White and others, convinced the Council of ASAE to sponsor a full day's program at both the November, 1923, national meeting at Chicago and in June, 1924, at Lincoln, Nebr. This led to organizing the Rural Electric Division in 1925. The chairmen are listed on page 386.

### National Rural Electric Project Functions

The National Project (21) was organized in June, 1928, and closed June 30, 1933. Responsible for its being were CREA, Nela, University of Maryland, the electric utilities of Maryland and the District of Columbia. A premise of the organization was, "All will benefit from rural electrification investigations if and when electric service becomes of value to the farmer economically and socially."

Five privately owned farms were wired and lighted to study electric service under practical conditions. Special attention was given to research which was supplemented in the laboratory at the University of Maryland. Lee C. Prickett started the project and was succeeded by George W. Kable, director and A. V. Krewatch, engineer. Also employed were an economist-sociologist, mechanic, and graduate students. The University staff and personnel from USDA Bureaus gave aid and 90 manufacturers furnished electric equipment. Power consumption and use studies were made on 46 processes plus others for the home, and 23 reports were given, with 90,000 copies being printed. All dealt with the development of new electric devices, or research findings, or both.

Fig. 7 The Thomas W. Martin plaque is awarded annually to an electric operating company

Fig. 8 Frank E. Watts plaque awarded annually to three operating light and power companies

## . . . Rural Electrification

### Government in Rural Electrification

Government support in bringing electric service to the farm was talked about by prominent officials as early as 1923 and perhaps earlier. Pennsylvania's Giant Power Survey (22) was undertaken by Governor G. Pinchot to prepare the way for cheap public power "particularly for the farmer. . . . No system can be considered socially sound which ignores the requirements of upwards of 900,000 farm population."

Morris L. Cooke, later administrator of Rural Electrification Administration, made notable contributions to bring electric service to agriculture. In 1925, he was the author of an article on rates for rural electric service (23).

### Rural Electrification Surveys

During the middle 1930's several surveys and studies were made to determine what might be done about rural electrification. At that time only one farm in 10 had electric service. All the studies indicated that many farmers wanted electricity and that their use of it in farm production and in the home would probably support extension of lines.

The most comprehensive national rural electrification survey of this period was made by the Federal Power Commission under the direction of J. P. Schaenzer. It was completed in 1935. Among other data, it showed on maps the potential market for rural lines and electric equipment for every county in the nation.

One study by the Mississippi Valley Committee, Public Works administration, found (24) that the big problem in rural electrification is not the cost of generation, but the cost of delivering it to the rural customer.

### Rural Electrification Administration Comes into Being

Out of these surveys and many others, both national and state, arose the REA on May 11, 1935, when President Franklin D. Roosevelt signed Executive Order No. 7037 under the Emergency Relief Appropriation Act. Later, on August 11, 1938, he indicated (25) that the Rural Electrification Act was born at Warm Springs, Ga. (It was his first experience in an area without electricity). He went on to say: "Electricity is a modern necessity of life and ought to be found in every village, every house and every farm in every part of the United States."

The executive order gave the first administrator, Morris L. Cooke, the authority "to initiate, formulate, administer and supervise a program of approved projects with respect to the generation, transmission and distribution of electric energy in rural areas." It was a part of a program to relieve unemployment. Toward the end of 1935 strong support was given the movement at national conventions by two farm organizations — the National Grange and the Farm Bureau Federation. Rural newspapers and farm magazines also got behind the movement.

On May 20, 1936, the U. S. Congress passed the Norris-Rayburn Farm Electrification Bill. This gave REA agency status and established as its purpose the promotion and advancement of rural electrification. The administrator was authorized and empowered to make loans with interest for construction of rural electric systems to serve persons

Fig. 9 New home of National Rural Electric Cooperatives Association, Washington, D.C.

in unserved rural areas. He also was authorized to make loans for the purpose of financing the wiring of the premises of persons in rural areas and the acquisition and installation of electrical and plumbing appliances and equipment. Under Reorganization Plan II, July 1, 1939, REA became a part of the U.S. Department of Agriculture.

Originally, difficulties were met in the formation of farm and rural people into cooperatives (26). The two major problems were, *(a)* the assurance that loans would be self-liquidating within a given period of time, and *(b)* that each prospective cooperative met the legal requirements of organization and incorporation of the state. It took time to gain the know-how and methods of procedure. Economic feasibility of the projects was strengthened considerably by REA's successful efforts to lower construction costs. By the end of 1936 REA borrowers were constructing "high line" at an average cost (26) of $941 per mile in nine states.

To show farmers and rural people how electric service could help them a "farm show" was organized and directed by REA. This successful caravan, exhibiting and demonstrating electric farm and home applications made 260 stops in 27 states, and played to an audience of 1,300,000 people. The show was on the road from October, 1938, to June, 1942.

As time went on, the miles of line energized, and the number of cooperatives organized, and consumers connected increased rapidly, Table 1. There was a slow-down during the 1942-1945 period because of the war effort. Table 2 reveals that the largest number of miles of line constructed and energized was in 1949—193,901 miles with more than one-half million consumers connected, or about 1430 for every day of the year.

The total consumers served by REA, December 31, 1955, was 4,251,250, (Fig. 6). On this same date the number of active borrowers was 998. Of these, 936 were electric cooperatives, 41 public power districts, 17 other public bodies and 4 commercial power companies. All are

TABLE 2. NUMBER OF REA BORROWERS WITH ENERGIZED SYSTEMS, MILES ENERGIZED, AND CONSUMERS SERVED BY YEARS (27)

| Calendar year | Number of borrowers | Total miles energized | All consumers served |
|---|---|---|---|
| 1935 | 2 | 0 | 0 |
| 1936 | 29 | 3,000 | 7,508 |
| 1937 | 126 | 16,500 | 43,878 |
| 1938 | 350 | 67,409 | 176,382 |
| 1939 | 548 | 181,359 | 435,566 |
| 1940 | 685 | 267,846 | 674,495 |
| 1941 | 773 | 348,062 | 902,266 |
| 1942 | 803 | 378,015 | 1,012,284 |
| 1943 | 811 | 390,058 | 1,087,801 |
| 1944 | 826 | 410,471 | 1,216,798 |
| 1945 | 848 | 449,579 | 1,408,918 |
| 1946 | 869 | 506,838 | 1,683,901 |
| 1947 | 911 | 603,064 | 2,046,095 |
| 1948 | 952 | 759,494 | 2,518,450 |
| 1949 | 995 | 943,385 | 3,040,425 |
| 1950 | 1007 | 1,088,777 | 3,413,407 |
| 1951 | 1016 | 1,178,515 | 3,665,966 |
| 1952 | 1020 | 1,244,645 | 3,858,396 |
| 1953 | 1022 | 1,297,264 | 4,024,826 |
| 1954 | 1024 | 1,332,937 | 4,174,346 |
| 1955 | 1026 | 1,361,605 | 4,251,250 |

NOTE — All figures are cumulative.

locally owned and operated. The average monthly energy consumption (27) for all farm and non-farm residential consumers was 242 kwh for 1955. This is growing steadily.

The achievements of REA can be attributed to the local nature of the program and the competence and vision of its administrators. The administrators were:

Morris L. Cooke—May 20, 1935 to Feb. 22, 1937
John M. Carmody—Feb. 23, 1937 to June 30, 1939
Harry Slattery—Sept. 26, 1939 to April 10, 1945
Claude R. Wickard—June 30,1945 to March 16, 1953
Ancher Nelsen—April 29, 1953 to May 14, 1956
David A. Hamil—June 26, 1956 to present

During the years REA has issued many excellent publications covering all phases of the subject. Beginning in September, 1935, it published its own monthly magazine *Rural Electrification News*. This was discontinued in 1953 and replaced with *Rural Lines* in 1954. Staff members also have written two books (28, 29). A number of motion pictures also have been produced concerning REA activities and the benefits to be derived by putting electricity to work in the home and farmstead.

### Farms Electrified Since December 31, 1919

On December 31, 1919, the Bureau of Public Roads, then a bureau in USDA, estimated that 100,000 farms had central station service, Table 1. By the end of 1935, the year that REA came into being, the record shows 788,800 connected. From then on rapid progress was made. On December 31, 1955, a total of 4,487,000 or 92.4 percent of all farms were receiving service. Of these 2,287,000 were served by cooperatives, 1,940,000 by electric power companies, and 260,000 by others.

The kwh used per farm consumer (30) east of the 100th meridian where little or no irrigation is used follows:

| Year Kwh | Year Kwh | Year—Kwh | Year Kwh | Year Kwh |
|---|---|---|---|---|
| 1955—3650 | 1949—2169 | 1943—1481 | 1937—1014 | 1931—775 |
| 1954—3246 | 1948—1997 | 1942—1239 | 1936— 954 | 1930—745 |
| 1953—3004 | 1947—1802 | 1941—1133 | 1935— 873 | 1929—672 |
| 1952—2864 | 1946—1669 | 1940—1073 | 1934— 811 | 1928—670 |
| 1951—2639 | 1945—1571 | 1939—1127 | 1933— 770 | 1927—618 |
| 1950—2335 | 1944—1461 | 1938—1045 | 1932— 765 | 1926—586 |

The record of kwh use on farms is outstanding. It should be observed that the number as a rule doubled about every 8 to 10 years. West of the 100th meridian, usage does not follow any consistent pattern, but varies with the rainfall and irrigation pumping requirements. Kwh per farm averaged 8180 in 1954, 7,804 in 1929, and 3520 kwh in 1941.

In most areas more electricity is used in the farm home than for farming purposes (31). This is verified by studies made in 10 major types of farming areas. The distribution for the several uses varied as follows: lighting 4 to 25 percent, water pumping 2 to 7, household appliances 58 to 87, and farm equipment 3 to 30 percent.

### Federal Extension Service Helps

S. P. Lyle in a talk, "Importance of Education in Rural Electrification Work" in 1939 in the Hayloft, World's Fair, New York (32) said, "It was in 1924 at a meeting at Montgomery, Ala., where I got my first induction into rural electrification education and where we actually got our fingers on the problem in the field. I have never lost interest in it." Since that day the federal and state extension workers have been a powerful force in bringing the message to the people. The latest directory of extension agricultural engineers records 64 of them in full or part time rural electrification education in 43 states and three territories. H. S. Pringle is responsible for the rural electrification extension program in the Washington D. C. office. The work of these men is supplemented many times by the activities of the county agricultural and home demonstration agents.

### 4-H Clubs — Rural Electrification

4-H Club work in rural electrification got started in the 1920's. By 1936 it had acquired such size that in cooperation with the extension service the National 4-H Rural Electrification Program was introduced by the National Committee on Boys and Girls Club Work with G. L. Noble, director. Westinghouse Electric Corp. is the sponsor.

Since 1955 it is called the National 4-H Electric Awards Program. The purpose is *(a)* to encourage the development of effective 4-H leadership, character and citizenship; *(b)* to encourage 4-H club boys and girls to learn more about electricity and the proper use and care of electric equipment; and *(c)* to encourage 4-H club members and clubs to help others learn more about electricity and its uses. More than 650 power suppliers cooperated and furnished training leaders in 1955. Westinghouse Electric Corp. supplied hundreds of thousands of copies of handbooks, literature, etc., to carry on the program.

Although announced late in 1936, 29 states participated with 2,063 4-H members entered. By 1953 all the states and territories accepted the program and in 1954 enrollment passed the 100,000 mark. In 1955, 44 states or territories qualified with 1754 counties. Medals were awarded to 4568 boys and girls, 29 plaques to counties, all expense trips for the state winners to the National 4-H Club Congress, Chicago, and six $300 scholarships to the national winners.

For six years Westinghouse Electric Corp. has sponsored a one-day power suppliers conference in conjunction with the National 4-H Congress. The objective is to provide an opportunity to exchange ideas on how they can better cooperate with the agricultural extension service state 4-H electric programs.

## . . . Rural Electrification

West Virginia, at Jackson's Mill 4-H Camp, dedicated in 1940 a fully equipped farm electrification building. In it are housed and demonstrated the most modern electric equipment for the farm and rural home. Trained personnel are on duty to meet with the 100 organizations that meet there on a 12-month schedule. Georgia, Texas, and other states have similar buildings.

### USDA Research Program

To a limited degree the U. S. Department of Agriculture has conducted research in rural electrification for many years. Based on their findings many valuable bulletins have been published. Separates by A. M. Daniels (10) and other publications (13, 14) were mentioned earlier.

The first full time investigator was S. P. Lyle in 1938 under S. H. McCrory, chief, Bureau of Agricultural Engineering. A few months later he was followed by Harry L. Garver. With limited funds the research was confined to the Bureau and a few states until World War II. Funds were reduced and the instruments and facilities turned over to R. B. Gray, head, Farm Machinery Section. On March 1, 1946, rural electrification was re-established as a separate function with T. E. Hienton as head of the section. The work has grown so that today 24 research specialists are employed in 15 states and Beltsville Research Center. The research in the states is on a cooperative basis. Some of the subjects under investigation are radio frequency for insect control, heat pump for agricultural purposes, bulk milk cooling, electric equipment for the dairy, etc. Out of these have come a number of bulletins, leaflets and press releases of practical application to the farmer.

### Rural Electrification Teaching

Teaching rural electrification courses in the colleges and universities since the late 1920's also had its impact on the acceptance of electric farm and home devices. Some of the institutions have quite a selection of courses from which to choose or major. This is true of Virginia Polytechnic Institute where many rural electrification specialists were trained under C. E. Seitz, head, agricultural engineering department. The outstanding electrified farm at Wisconsin University has served most successfully both for teaching and research purposes under the direction of F. W. Duffee (33).

Prospective high school vocational agriculture teachers are also trained in rural electrification. Through them the information gets to the high school boy who puts the knowledge to practice on the farm.

Farm electrification instruction in the high schools is widely distributed over the United States and through it has contributed greatly to the welfare and comfort of rural people. To incite interest in the subject the Future Farmers of America Foundation makes local, state, regional and national awards to students on a competitive and achievement basis. On the local level the awards are medals, and $6100 yearly to winners above the Future Farmer of America chapters.

Three books have been published by agricultural engineers suitable for high school classes. These are: *(a)* "Rural Electrification," by J. P. Schaenzer, fifth edition; *(b)* "Electricity in the Home and on the Farm," by F. B. Wright, third edition; and *(c)* "Farm Electrification," by R. H. Brown.

### Rural Electrification Magazines Serve

The oldest of the magazines is *Electricity-on-the-Farm* founded July, 1927, when about five percent of the farms were connected. Fred Shepperd was the editor and Farm Light and Power Publishing Co., publisher. Through the years it has been the informing and coordinating factor between farms, the electric power suppliers, manufacturers and dealers. From 1933 to 1956 Mr. Shepperd was editorial director, then W. J. Ridout, Jr., succeeded him. In the interim agricultural engineer, George W. Kable edited the magazine from October, 1937 to December, 1950, W. J. Ridout, Jr., February, 1951 to February, 1956, and Hugh J. Hansen at this time.

Another magazine in its 13th year is *Farm Power* formerly *Co-op Power,* with Roy H. Park as editor. It is published monthly and known as the "national trade magazine for rural electrification." Other magazines are mentioned in other sections of this article.

### Electric Water Systems Council

The National Association Domestic and Farm Pump Manufacturers was established in 1932 with Herbert C. Angster as director. It joined with Edison Electric Institute and created the Electric Water Systems Council. The organization was formed to promote the use of electric pumps and water supply equipment in rural areas. Committees met and sales promotion plans were developed. Sales increased from 50,000 pumps in 1932 to 788,000 water systems in 1955. The "Manual of Water Supply and Equipment" was produced. The present third edition is a recognized text on the subject. John Hosford is the present executive secretary.

### Tennessee Valley Authority — Research and Extension

Agricultural engineers served well in both research and extension activities of TVA. In 1934 George W. Kabel established projects in both fields. The farm electric research (34) was devoted mostly to income-producing or labor-saving equipment and carried on with existing agricultural agencies. Contracts were signed by TVA and state extension staffs to partially support rural electrification specialists. Twenty years ago TVA employed five men on farm electrical research, and two men and two women on education. Kable was succeeded by C. J. Hurd in 1937. Others who headed up the work or held responsible positions were G. E. Henderson, D. E. Washburn, Julian M. Fore, and A. T. Hendrix.

In addition, over a period of many years, TVA has aided many groups (35) and continued a widespread program to encourage the use of electricity. Among these—"One of the most significant activities during the year was the promotion of farm water systems in 1954 . . . Hundreds of demonstrations were made by TVA agricultural engineers (under the supervision of W. R. Walker, electric development specialist) and representatives of distributors. TVA also conducted 28 water system workshops. . . . Other electric development activities included farm workshop demonstrations, farm wiring meetings and home appliance demonstrations . . . Tennessee led all other states in the number of 4-H Club members with electricity projects." Many publications of a practical content such as "Pumps and Plumbing for the Farmstead" and "Wiring and Lighting the Farmstead" were

released in the early 1940's. The program has been successful as the average energy consumption per farm of 4000 kwh per year indicates.

### Farm Electrification Awards

Two national awards are made annually by the Edison Electric Institute. They are The Thomas W. Martin Rural Electrification Award (Fig. 7) and The Frank E. Watts Award (Fig. 8). The Martin award, a plaque, was made possible through the generosity of Thomas W. Martin, former president, Alabama Power Co. He was one of the stanchest supporters of the rural electrification movement. Annually since 1932 the award is "offered to the electric operating company in the United States that during the previous calendar year makes the greatest contribution to the progress of Rural Electrification—Agricultural Advancement in the area it serves."

The Frank E. Watts plaques are given each year since 1950, in memory of a foremost worker for rural electrification by *Farm Journal* magazine to three operating electric light and power companies for "excellence in promoting farm electrification as a productive force for better farming and better living."

It is regretted that space does not permit to list all the award recipients, agricultural engineers, and their companies.

### National Electric Manufacturers Association Participates

The Nema Farm Electrification Bureau was organized in 1938 with Frank J. G. Duck, manager, and presently is headed by Russell J. Gingles. One of its primary purposes is, through a series of articles, to awaken especially the agricultural press.

The bureau's operations are guided by the electric farm equipment industry, farm and rural committee and subcommittees. The program is flexible and currently is directed toward assisting power suppliers to combat gas competition, to encourage adequate wiring for farmsteads, to provide consumers with information on the uses of electricity, and to assist farm equipment manufacturers in electrifying their products. Hundreds of pieces of literature, slide films, teaching aids and other material have been prepared for distribution to power suppliers, farmers and rural youth groups.

### Edison Electric Institute

The Rural Service Division, Edison Electric Institute, with J. P. Schaenzer, head, was inaugurated in September, 1939. Mr. Schaenzer served until May, 1941, and also as editor of *Rural Electrification Exchange*. It was re-established in February, 1946, with Roy W. Godley as manager until September, 1947, then W. J. Ridout, Jr. to January, 1950, and now Harold H. Beaty.

The Farm Section organized under the division is made up of four committees; farm utilization, rural youth, agricultural development, and farm sales promotion. Their functions (36) are to solve particular problems of rural living, to increase the value of electric service to rural and farm families, and to undertake projects of sound economic value to American agriculture. Chairmen of the Section have been C. H. Leatham 1944-'46; E. C. Easter 1946-'48; J. C. Cahill 1948-'50; R. T. Jones 1950-'52; E. D. Smith 1952-'54; B. S. Moss 1954-'56 and now M. O. Whithed.

The division publishes "Farm Electrification" bimonthly. Other contributions are "Farm Electrical Equipment Handbook," of 100 uses; "Farm Electrification Manual," of 17 sections on electric farming enterprises; "Farm Electrification Research," third edition; and many more equally worthwhile releases.

### National Rural Electric Cooperative Association

As the local rural electric cooperatives became established several state associations were organized to develop for themselves efficient management procedures and to perform certain services collectively.

Then in March, 1942, in order to perform additional services which they were not able to obtain otherwise, the rural electric systems organized the National Rural Electric Cooperative Association, (NRECA) (37). The association has a membership of 934 cooperatives and power districts representing 3,801,777 connected consumers (25).

Each year an annual meeting of member systems is held attended by directors, managers, attorneys and other top employees to exchange ideas and information, express themselves on the issues and formulate policies to govern the organization. Ten working committees also meet to advise and assist NRECA in its efforts to aid the member systems in specialized fields. The governing board consists of one director elected from each state in which there is a member system. Clyde T. Ellis has been general manager of the association since its beginning.

The comparatively small staff of the national office is responsible to the local cooperatives and others for technical and other assistance. This is accomplished in part through the professionally produced monthly magazine *Rural Electrification*. NRECA also supplies information and materials for use of the rural electric systems in their power use and public relations programs; carries out legislative activities and does research work in technical fields of management, economics, engineering, and communication; and provides insurance and retirement programs for them and their employees. Fig. 9 shows new home of NRECA in Washington, D. C.

### National Farm Electrification Conference

The National Farm Electrification Conference was organized and held its first national meeting in 1946. Its ultimate purpose was to increase the efficiency of the farm family as a factor in both the economic and social life of the nation. Of immediate concern were: *(a)* to search for, discuss and promote tools and techniques designed to assist agriculture through the increased efficiency and economic use of electricity, and *(b)* to promote acquaintanceship and understanding among, not only participants of the conference, but also all others engaged in farm electrification and in the use of electrically operated equipment and appliances for farm and home uses. Successful national conferences were held anually for a period of nine years with the following chairmen:

George W. Kable—1946
Hassil E. Schenck—1947
Frank E. Watts—1948
H. P. Rusk—1949
P. D. Sanders—1950
L. L. Rummell—1951
John Strohm—1952
H. E. Slusher—1953
Karl H. Runkle—1954

## . . . Rural Electrification

For the past three years a small task force composed of one representative of each of the 16 participating organizations has carried on the business of the conference with chairmen as follows: Karl H. Runkle, 1955; J. R. Cobb, 1956; and W. J. Ridout, Jr., 1957. During its existence Russell J. Gingles has served as secretary and Karl Gorham as treasurer.

### Bonneville Power Administration Research

Over a period of several years (1950) BPA (Bonneville Power Administration) invested considerable money for research on a cooperative basis with eight or more colleges of the Northwest. Investigations of special interest to agricultural engineers included cranberry washing and drying equipment, plans and specifications of farm and home refrigeration plants, dairy water heating, livestock feeding, high frequency blanching of vegetables, food sterilization, electric house heating and sprinkler irrigation. Roger Conkling served as liason for BPA.

### Inter-Industry Farm Electric Utilization Council

With increased farm use of electricity as its goal, the Rural Electrification Administration in the spring of 1954 sought the aid of power companies, electric cooperatives, manufacturers, agricultural agencies, and farm publications in planning the coordination and intensification of power-use promotional activities.

More than 200 representatives of these various groups met at a REA-sponsored meeting in Chicago, decided they should and could work together toward this worthy objective, and formed the I-IFEUC (38).

The objectives of the council are: "to encourage the gainful use of electric power on the farm; to initiate and coordinate activities which lead to increased and beneficial use of electricity in agricultural production and which help to advance the economic and living standards of rural America; and to counsel with and seek the cooperation of all interested individuals, groups and associations in the planning and furtherance of economically sound power-use promotional efforts."

Six voting members, three representing the rural electric cooperatives and three the electric power companies, comprise the action level of the council. A seventh but non-voting member, Fred H. Strong, deputy administrator, REA, has served as chairman since the Council's inception.

### Conclusion

There is an old saying, "many hands make fast work." Considering the many individuals, farmer organizations, government agencies, electric cooperatives, power companies and municipalities, manufacturers, distributors and dealers, associations, the press and other groups that took such an active part in bringing electric service to the farm and rural areas, it is no wonder that about 95 percent of all the farms of the nation are electrified today. As related, a few farms were connected in 1898 but it took time to acquire the necessary momentum to do the job. But, when it got rolling most of the farms now receiving service were connected during the past 20 years.

That the rural people want and need electric service is shown by their ever increasing yearly use. It would seem that as a whole, electricity has added more to the farmer's general welfare than anything else during the present century.

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*(Continued on page 459)*

# Trends in Rural Electrification

**Truman E. Hienton**
Fellow ASAE

ELECTRIC service on farms of the United States was practically unknown at the birth of the American Society of Agricultural Engineers a half-century ago. Today with electric service in use on 19 out of every 20 farms in this country, electricity not only drives darkness from farm buildings but has assumed an important share of the farm power load and an irreplaceable function in helping to maintain the comfort and health of farm families.

Extension of electric service to farms and rural areas has had a pronounced impact on the sources and amounts of energy used on farms, on methods and equipment for farm operation, and on the improvement of farm living conditions. Electric power has been of primary importance in western states in bringing land into production by pumping water for irrigation. Its increasing availability on farms generally has provided impetus to the acceptance of the milking machine and other machines to reduce hand labor. Electric service to hatcheries, cold storage plants and other enterprises in rural communities has indirectly produced economic benefits to farmers by operating mammoth incubators for hatching chicks, refrigerating machines for vegetable and fruit storage, and locker plant equipment.

Electric energy from central station service was used on a few farms as early as 1898 in California and Pennsylvania, but the first authentic figures on the amount used in one year are those for 1924 reported by Kinsman (1)*. During that year electricity furnished 900,000,000 hp-hr (675,000,000 kw-hr) or 5½ percent of the entire farm power load. This energy use had increased to 722,633,000 kw-hr in 1926 and the data available indicate that it has increased steadily since that time with the exceptions of the period 1932-35 and years 1950 and 1955 (2). The marked reduction shown for 1950 is attributable to the change in definition of a farm by the U.S. Bureau of the Census and an accompanying reduction in the number of farms served. Both of these changes are clearly evident in the curves shown in Fig. 1. The 1954 census reported a decrease in number of farms with electric service of 571,000 (shown for 1954) but despite this drop only 8 million fewer kilowatt-hours were used in 1955.

Total electric energy use on farms in 1956 was more than 22 billion kw-hr, or nearly 33 times that used 32 years previously. During the same period the number of farm customers had increased more than 22 times. These figures indicate the immensity of the change in use and application of electric energy on farms during that period. They do not show the nature of the amount or extent of the changes affecting other sources of energy through substitution or use for entirely new requirements. There are figures available on the use of specific items of electric equipment which indicate where energy changes have occurred. Several of these will be mentioned in subsequent paragraphs.

The first installation of an electric motor to drive an irrigation pump was recorded to have been made near Yuba City, Calif., in 1898. Evidence of the pioneering nature of this early installation is verified by the following extracts from the 12th census of agriculture made in 1900 and reported in 1902: "In some localities, where horses have little value, pumping by horse power is in vogue. The practicability of irrigation in this way is limited largely by the depth of the water, and the number of animals available." . . . "The most important source of power for pumping is wind."

A California power company extended service to ten farms in 1899 with an irrigation-pump load of 175.5 hp. This company continued to expand electric service to farms for irrigation pumps and by 1904 it was serving 1406.0 hp, 2928.0 hp in 1907, 4430.0 hp in 1909, 6654.0 hp in 1911,

*Numbers in parentheses refer to the appended references.

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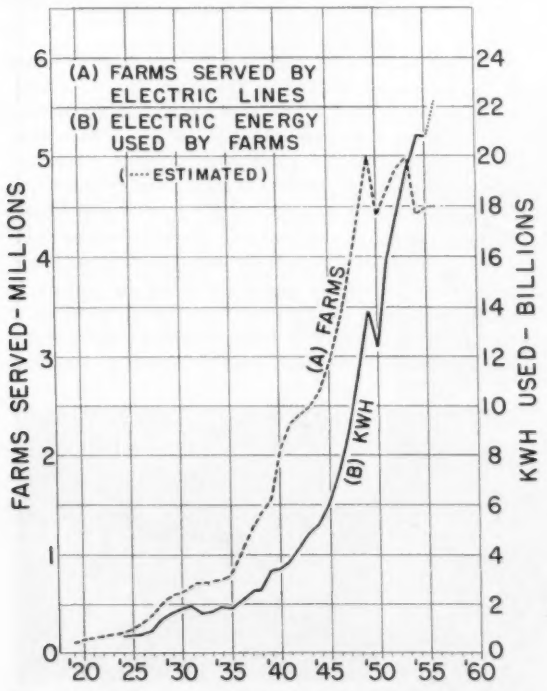


Fig. 1 Trends in number of farms in United States with electric service and in use of electric energy on those farms are shown in curves A and B

TABLE 1. IRRIGATION PUMPS AND POWER UNITS IN NINETEEN WESTERN STATES, 1909 - 1949

| Year | Irrigation pumps, number | Electric motors, number | Electric motors, hp | Other power units, number | Other power units, hp |
|---|---|---|---|---|---|
| 1909 | —— | —— | 51,599 | —— | 309,881 |
| 1919 | 33,804 | 12,743 | 289,018 | 21,061 | 456,953 |
| 1929 | 61,445 | 44,165 | 876,166 | 17,280 | 407,253 |
| 1939 | 78,528 | 50,597 | 1,118,024 | 27,931 | 649,848 |
| 1949 | 155,599* | 104,761 | —— | 49,452 | —— |

*Includes Florida, 7,616 pumps.

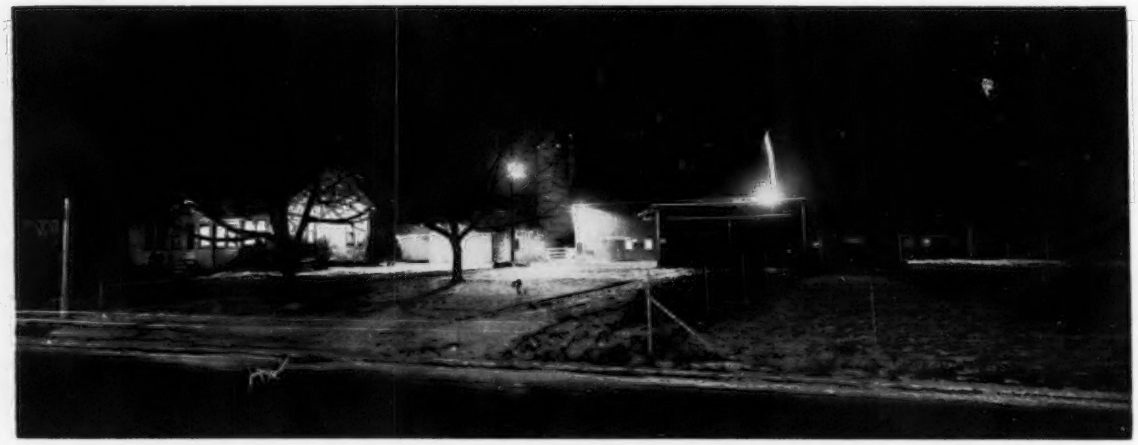

Fig. 2 Electric lighting in the farmhouse and farm buildings, and for the farmstead is of primary interest to the farm family

and 12,470 hp in 1913 (3). Pumping for irrigation continued to expand in California and spread to other western states. Figures in Table 1 taken from U. S. Census Bureau reports indicate the extent of this continued expansion in the western region.

It may be noted that an exceptionally large increase occurred in the decade 1939-49 in the number of pumps installed. During the same period the acreage irrigated by pumping in the 20 states increased from 21.1 to 26.2 millions. Unpublished data indicate that the number of electric motors driving irrigation pumps in these states has continued to increase since 1949 particularly in Nebraska and Texas.

Electric motors are operating irrigation pumps in the humid area (28 eastern and southern states) but in much smaller numbers and percentage of all power units. During 1955 there were 17,588 irrigation pumps in this region, of which 7,530 were installed in 1946 or later. Total area irrigated in 1955 was 487,495 acres. Electric motors operated 2,335 pumps and, in combination with other power units, an additional 1,773 pumps.

Hand labor for milking has been materially reduced in the past 25 years with the improvement in milking machines and extension of electric service to farms. The increase in number of farms with milking machines has paralleled the increase in farms with electric service. Beginning in 1910 with 12,000 the number of milking machines has increased to 55,000 in 1920, to 100,000 in 1930, to 175,000 in 1940, to 365,000 in 1945, to 635,863 in 1950, to 711,776 in 1954, and to an estimated 715,000 in 1956.

Electricity has had an important part in the establishment of a rural industry, commercial chick hatching, because of the use of electric power for operating mammoth incubators. These machines, developed chiefly during the mid-twenties, require electric fans and many use electric heaters in their operation. These commercial hatcheries produced 671,576,000 chicks in 1930 and more than three times that number, 2,123,576,000 in 1956. Total capacity of these incubators exceeds a half billion eggs. Ready availability of day-old chicks and poults to farmers and poultrymen from hatcheries has become of considerable economic importance for annual replacement of hens to produce eggs, for turkey raising, and for commercial broiler growing.

A second major rural industry, the frozen-food locker plant, has developed because of the availability of electric service in rural areas. While farmers have been renting refrigerated space and storing food in lockers for more than 40 years, the modern locker plant, with its sharp-freezer and meat-processing service, began not more than 25 years ago. The industry showed a slow and steady growth until World War II when shortages of materials slowed further expansion. Since the war, the industry has grown rapidly and nearly half of the 10,553 plants operating on January 1, 1955, had been built during 1945-51. During 1954 these plants slaughtered 2.8 million head of livestock and custom-processed 1.6 billion pounds of food for a total of 5 million

Fig. 3 *(Left)* Electric lighting in this kitchen designed by home economics specialists of U.S. Dept. of Agriculture provides adequate illumination at any location • *(Center)* Freezers in use in 1½ million farm homes in the United States help to preserve many home grown foods • *(Right)* Television sets on farms increased more than 1½ million during the 4-year period 1950-54

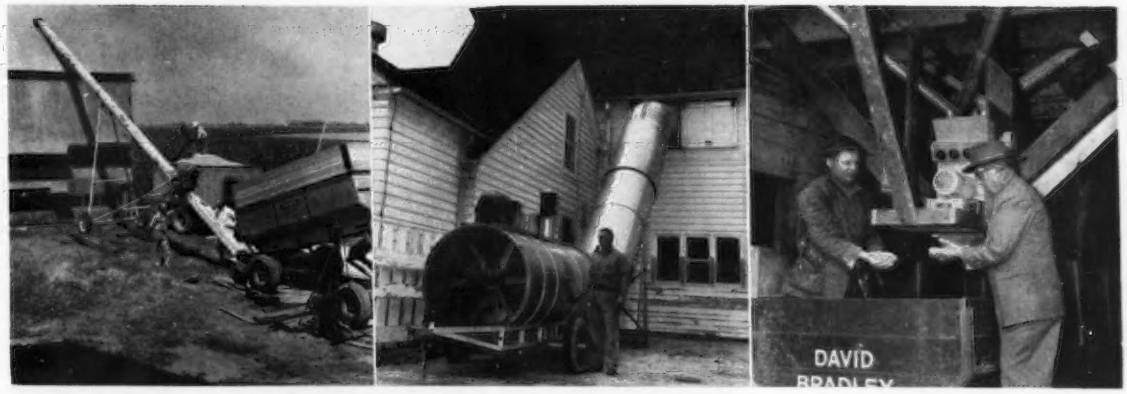


Fig. 4 *(Left)* Motor-driven portable elevators are reducing hand labor on many farms in moving heavy materials • *(Center)* Electric crop driers reduce moisture in grain and forage crops to preserve quality and provide for safe storage • *(Right)* Automatic feed grinder on an Illinois farm has been produced after years of engineering research and development

## . . . Trends in Electrification

patrons. These plant patrons included 3 millions who rented lockers at these plants and nearly 2 million home-freezer owners who hired the locker plants to process and freeze the food for home storage (4).

There are numerous other rural industries important to farm operation for which rural electric service has provided necessary power and light entirely or in part. Among them are the cotton gin (7,069 in 1954), country grain elevator, feed mill, sawmill, milk pasteurizing and bottling plant, cheese factory, egg assembling and grading plant, poultry dressing plant, wool-scouring plant, and vegetable and fruit processing and cold storage plants. Many of these are co-operatively owned and operated by groups of farmers but all of them are inseparably connected with farm operations.

While the extension of electric service to farms and rural communities has produced very significant changes in farm power use and rural industry development, probably the most important effect has been produced on living conditions in farm homes. The individual farm electric plant introduced electric lighting in many thousands of farm homes, but the rural electric line has provided electricity for the first time to the vast majority of farm houses now lighted by electric lamps. This impact is best illustrated by a remark commonly heard from farmers expecting electric service in a short time: "We are getting electric lights soon."

Modern lighting, brought by electric service to farm homes, has improved living conditions tremendously for farm families, but other applications of electricity, too, have aided in improving home comfort and in reducing labor in the household. The radio and television sets have decreased

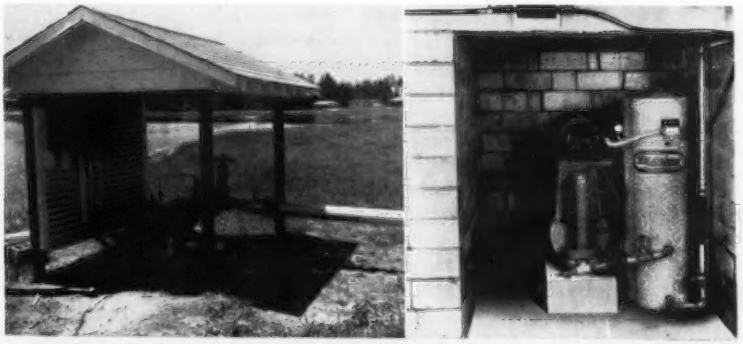

Fig. 5 *(Left)* 50-hp electric motor drives irrigation pump at Clayton, N. Car., for supplementary irrigation • *(Right)* This automatic electric water pump installation which furnishes running water to farmhouse and farmstead is typical of nearly 3 million on farms in United States

Fig. 6 *(Left)* Limited-input or farm-type electric welders are an important tool in the farmshop to repair existing machines or fabricate new ones • *(Right)* Adequate light properly located in the farm workshop is provided by this fluorescent fixture to make repairs possible during darkness

Fig. 7 *(Above)* Infrared lamps and electric pig brooders have reduced the loss of young pigs at farrowing during cold weather

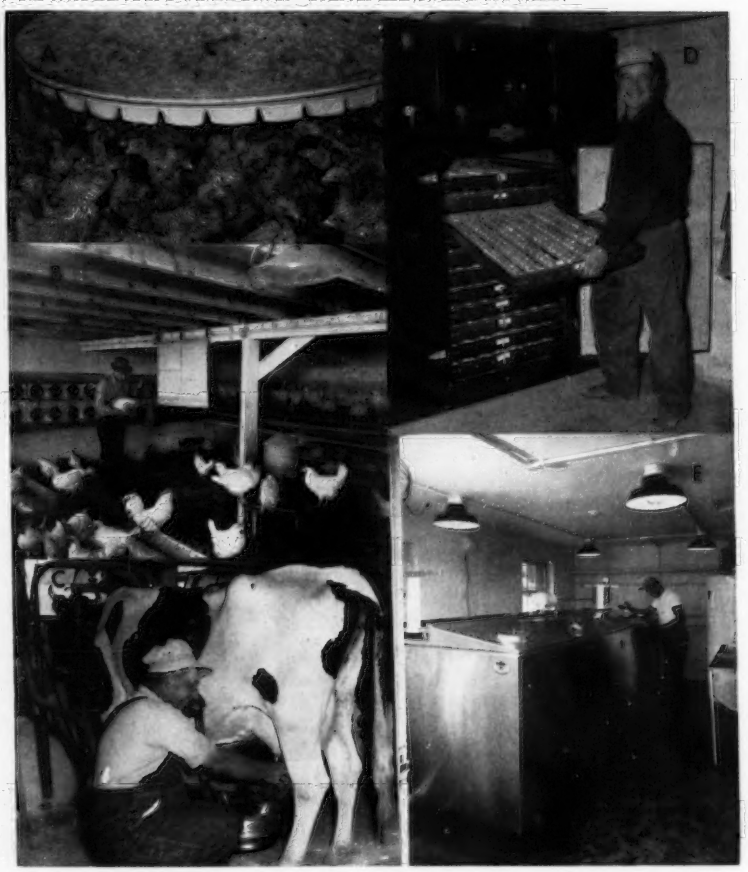

Fig. 8 *(Right) (A)* Electric chick brooders have reduced labor in raising chicks and increased safety from fire. *(B)* Electric lamps in the poultry house stimulate winter egg production when egg prices are normally highest. *(C)* The electric milking machine has increased rapidly in recent years to reduce labor in farming. *(D)* Mammoth electric incubator in operation at Illinois hatchery. *(E)* Mechanically refrigerated bulk milk coolers are being used on 60,000 dairy farms in the United States. Electricity also operates the water heater and milk-house heater on this Penn. dairy farm

the isolation of farmhouses formerly considered an inescapable part of farm life. The mechanical refrigerator has provided needed refrigeration for family foods and the food freezer a storage facility for preserving them for long periods of time. The electric motor-driven pump has for the first time furnished running water automatically for various household needs on the majority of farms. The motor-driven washer has reduced the farm housewife's heavy labor load on washdays and electric irons and ironers have further eased the labor involved in farm laundry work. Many other electrically powered or heated equipment items and appliances have contributed to improving farm living conditions and in reducing labor in farm household tasks.

The extent to which electric equipment and appliances have been adopted in farm homes is indicated in various reports particularly those of federal censuses of agriculture. The universal desire for electric lighting is shown in the summary report of 10 recent area studies on the use of electricity on farms made in 15 states by the following statement: "Lighting was the only application of electricity made on all the farms in all the surveys" (5). The first enumeration of radios on farms was made in 1925 when there were 284,006 sets reported on 4.5 percent of all farms. Similar figures obtained in 1940 and 1945 showed 4,159,368 (58.5 percent) and 4,264,007 (72.8 percent) farms, respectively, with radios. A similar but relatively more rapid increase in television sets on farms occurred from 1950 to 1954 with 154,090 farms (3.2 percent) reporting them during the first enumeration and 1,698,548 (38.2 percent) listing them four years later.

Figures on increase in acceptance of mechanical refrigerators comparable to those for other electric items mentioned are not available. The 1945 Census of Agriculture does list 1,737,643 mechanical refrigerators installed at that time on 64.8 percent of farms reporting electric service from a power line. A rapid increase in the number of food freezers on farms occurred during the period 1950-54. There were 650,512 units (12.1 percent) in 1950 and 1,541,415 (32.2 percent) in 1954. Figures are available for the period of 1920-1954 on the increase in farms reporting running water available. These are listed in Table 2 according to total number and percent of all farms. The figures for 1950 are *electric* water pumps on farms. The types of power unit on pumps were not included in other enumerations.

Running water in the farmhouse not only reduces labor but provides the key to utilization of devices for which water under pressure must be available such as the flush toilet, automatic washing machine and hot-water heater. Census

TABLE 2. RUNNING WATER ON FARMS IN THE UNITED STATES

| Year | 1954 | 1950 | 1945 | 1940 | 1930 | 1920 |
|---|---|---|---|---|---|---|
| No. farms | 2,810,531 | 2,018,578 | 1,679,023 | 1,340,025 | 994,202 | 643,899 |
| Percent all farms | 58.8 | 37.5 | 28.7 | 22.0 | 15.8 | 10.0 |

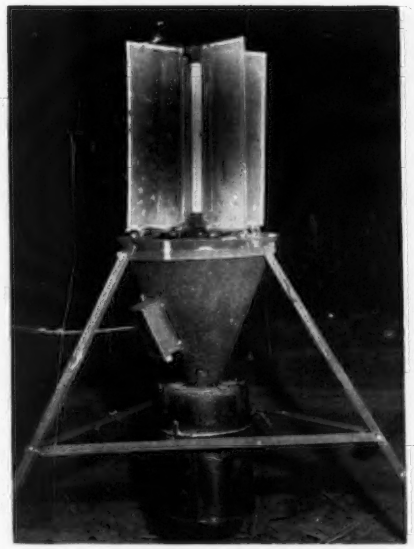

Fig. 9 Electric survey insect trap developed by USDA agricultural engineers for determining emergence and abundance. The ultraviolet lamp used attracts the adults of many insects

Fig. 10 Mechanically refrigerated apple storage at Michigan orchard enables grower to market fruit when desired

Fig. 11 Commercial adaptation of electronic device for detecting blood spots in eggs which was originally developed by USDA agricultural engineers

figures reported the number of power-driven washing machines on farms for 1945 as 2,512,155. The 1950 enumeration which specified *electric* washing machines reported 3,160,141 farms with this equipment. At the same time (1950) there were 936,066 electric water heaters on farms. Inspection of the numbers of farmhouses with running water and electric washing machines in 1950 indicates that washing machines (not necessarily automatic) are adopted more quickly than electric water pumps. Figures on the numbers of other electric appliances in farmhouses, such as household milk pasteurizer, churn and sewing machine, are not available from the Census. Those which have been cited, however, furnish adequate evidence of the rapid change produced in farm living with the arrival of electric service at farm homes of the United States.

Electric water pumps which supply water under pressure to farmhouses usually furnish water at desired locations around the farmsteads to economically reduce the labor involved in hand pumping and carrying water. Water available to livestock at all times is a necessity for efficient meat, milk and egg production. Water applied under pressure to the farm garden as supplementary irrigation helps to insure the vegetable and small fruit production required for the farm family. Thus the electric pump which serves both the farmhouse and the farmstead is probably the most important electrically driven machine on the farm.

Introduction of electricity on farms has been accompanied by the development of many new applications of power, light and heat. A mere listing of the several hundred known uses would not serve to indicate their value or importance. It is believed more pertinent to mention a limited number of uses which have general application or are of particular value to specific types of farms.

Certain electric equipment, in addition to the water pump, is essential on all types of farms, especially farm shop equipment. The limited-input or farm-type welder, developed particularly for use on single-phase service, is one of the foremost in importance. Metal and woodworking machines find frequent use. The tool grinder is a necessity and the air compressor is rapidly becoming so. Electric hand saws, too, reduce labor to a certain extent, and they are increasing in farm shops.

Another class of equipment with general application to most types of farms, which may be driven by electric power, is that for moving materials mechanically. Machines included in this class are hoists, elevators, blowers and conveyors. Labor scarcity and cost have focused research attention on these machines recently and, while progress is being made, many possibilities for further development exist.

A third class of equipment, that for drying, has wide application for the drying of grain and forage crops. Benefits to be gained by such drying to remove moisture in excess of that for safe storage and to preserve quality are gaining increased recognition. An estimated 25,000 driers are now on farms and additional units are being installed. Electric power is being used to operate the fans in many installations particularly for forage drying but other power units are also being employed on the larger grain-drying units.

Some equipment, while not applicable to all farms, is often suitable for use by a closely related group of specialized farms such as the livestock group which includes dairy, poultry, hog, sheep and beef cattle. An example is the auto-

matic feed-preparation unit which will grind and mix grains and other ingredients for feed. Other examples of general application to this group are electric ventilators for livestock structures, electric fencers, electric clipping and shearing machines, and electric heaters (including infrared lamps) for reducing losses of young animals.

Equipment of this type which has been developed and generally accepted includes the electric fencer of which several millions are in use, and the electric clipping and shearing machine. The electric pig brooder (similar equipment used for lambs and calves) reported in use on 117,050 farms in 1954, and electric ventilating equipment for livestock farms and poultry houses are less numerous but rapidly increasing in numbers. Feed grinders driven by electric power were reported by 61,923 farms in 1950 but very few of them were of the automatic type which is a recent development.

Some equipment, usually if not always operated electrically, has been developed for specific types of farms. The milking machine, mentioned earlier as to acceptance, is such an item for the dairy farm. A second is the mechanical milk cooler which is of great importance to the dairyman in preserving the original quality of milk and in obtaining a higher price which the higher quality product commands. On dairy farms where milk is sold at retail the pasteurizer and homogenizer are equally necessary. The gutter cleaner, a conveyor of special design for moving manure out of stanchion-type dairy barns, is also becoming an important item of dairy farm equipment because of its labor-saving feature.

Numerous items of electrical equipment have been developed to meet the need of the poultry farmer. Mammoth electric incubators, previously mentioned, are operated on many poultry farms. Development of electric brooders, which began about 1920, has produced a variety of designs used by the poultryman to raise his young chicks and turkeys. Electric chick brooders were reported by 800,477 farms in 1950, or 19 percent of all farms with electricity.

Use of electric lamps to lengthen daylight hours during the short winter days has become an established practice to regulate egg production in chickens and turkeys. An electrical device of recent development, the debeaker, has been widely accepted in a relatively short time. Egg cleaners and egg washers, developed specifically for removing stains from eggs, are in general use. Mechanical egg graders reduce labor in sizing eggs for market, while recently developed electric scanning devices sort out those with undesirable blood spots or indicate those with green mold development. These new devices are just being applied to egg-grading machines. Mechanical egg coolers, designed to quickly cool and hold eggs under conditions necessary for quality preservation, have been developed during the past few years and are being installed by poultrymen where egg-price differentials warrant their use.

Several special machines which are usually driven by electric power are commonly used on farms specializing in fruit or vegetable production. These machines aid the grower in preparing his produce for marketing immediately or after a holding period. The washer, sizer or grader, and waxer are used as needed to prepare the material for packaging and direct sale or storage. Many producers operate their individual storages for Irish potatoes, sweet potatoes, onions and apples or other produce. Some of these storages are equipped with mechanical refrigeration units, others may use only mechanical ventilation for maintaining desired conditions. Vegetable growers have found electric heating of hotbeds, developed in Europe about 30 years ago and adapted to conditions in the United States several years later, a very practical and economical method. Both lead-covered and plastic-covered heating cables are used to provide heat and lamps are also used to a limited extent.

The discussion thus far has been concerned with *known* trends in rural electrification and its effects on farming and rural industry. Data presented have attempted to show some of the changes in farming produced by the extension of electric service to more than 90 percent of all farms in the United States during the 50-year existence of the American Society of Agricultural Engineers. Many members of this Society have been engaged in rural electrification activities in the past and will continue to be in the future, so attention is directed to possible *future* trends.

The curves in Fig. 1 of farms served by electric lines and of energy used by those farms show that total energy use has increased almost constantly despite decreases in numbers of farms. This past trend of increase in total electric energy use on farms and average use per farm is expected to continue in the future. This statement is based on the fact that many known economical uses for electricity on the farm which have not yet been generally adopted are being increasingly accepted. It is also based on the fact that new applications of electric energy, some of which are already on the horizon, will be developed to aid farmers in increasing the efficiency of their production and in marketing their commodities.

There are several farm operations utilizing equipment, which may require the use of electricity, that seem likely to increase. One of these, electric water pumping for the farmhouse and farmstead by automatic pumps instead of by hand, will be high on the list. Supplementary irrigation in the humid area (the 28 southern and eastern states previously mentioned) is also expected to increase, although the type of power unit used may be dependent on availability of three-phase electric service. Another farm operation, grain and forage crop drying, is expected to increase because of the potential shift to earlier corn harvest by field shelling machinery and increase in forage drying. Electric power is most likely to be used on forage driers and those used for grain and forage, but power units used on large grain driers may depend upon availability of three-phase service.

Other operations utilizing electric power may be expected to increase with the improvement of equipment to reduce hand labor and especially where machine operation may be made automatic or at least semi-automatic. Of primary importance among such farm machines are those for moving materials including grain, feed, hay, silage, bedding and manure. In addition, certain specialized operations, such as tobacco curing and honey preparation, have need not only for equipment for mechanically handling the materials, but also for special equipment or machines to complete specific phases in the production of that commodity. In the case of tobacco, the curing equipment is the primary need, and for honey preparation the uncapper, extractor and other equipment are required. Recently invented controls for both radial and reversible honey extractors now make possible their semi-automatic operation.

The use of refrigeration machines which will aid the farmer in maintaining the quality of his produce and in marketing it will certainly increase in the future. Milk coolers probably of the bulk-tank type and coolers for eggs either for hatching or retail market outlets will be used in greater numbers. Mechanical-cooling equipment for air conditioning of farmhouses is expected to increase and such equipment may be adopted to some degree for animal shelters.

The second factor advanced in support of the trend for continued increase in the use of electricity on the farm is that of the development of new applications. The following discussion of such possible new uses for electricity is presented by the author as his own and does not imply the official approval of the organization by which he is employed.

New electrical equipment is needed for controlling the environments for both plant and animal production and will probably be developed as the basic factors of such environments become more adequately known. These basic factors include temperature, humidity, light and other radiation, and air composition in their relations to the physiology and pathology of plants and animals.

Electrical methods and equipment for control of some insects and some plant and animal diseases may possibly be developed. Much remains to be learned about electromagnetic fields and their interrelationships with living systems and, as more information is obtained through research, such possible development will be more definitely indicated.

Electric soil treatment for destruction of soil-borne insects, nematodes, and plant pathogens, and for reduction of undesirable salts in soils have all been reported as productive of favorable results. Future possibilities of electrical applications for destruction of insects, nematodes and plant pathogens are dependent upon the development of economical methods and equipment. Further research to determine results of electric soil leaching is necessary to establish the soundness of limited work which has been reported.

More machines operated automatically by electric motors to do routine farm jobs are needed and will likely be devoloped. Progress in this field on farm machines is far behind that on industrial machines due to lack of electric power on farms until relatively recent years, limited demand for specialized farm machines, and costs of machines. Rising farm labor costs and industrial competition for labor will hasten the development of more automatic farm machines.

How electricity will be used on farms in the future may well be asked in closing this article. The answers will likely be given by research and development engineers, manufacturers, and farmers and their families. Will the electronic range now available be accepted by farm housewives? Will the heat pump become the heating and cooling equipment for the farmhouse? Will electronic cooling replace present cooling equipment? Will new automatic farm machines be developed to reduce hand labor on farms? Answers to these questions will be furnished by farmers themselves as manufacturers compete for future sales.

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## . . . 50 Years in Farm Buildings

*(Continued from page 432)*

**Conclusion**

Great progress has been made during the past 50 years in adapting farm buildings to our mechanized agriculture, but the process of modernization is still far from complete. Changes now in progress, such as the consolidation of farms into still larger units, will require continued improvement in buildings. Research and extension effort by public service agencies and industry are greatly needed to help farmers in the gradual improvement of farmsteads, buildings and facilities through

- Modernization of existing buildings by means of simple structural changes and installation of labor-saving equipment.
- New buildings planned to accommodate mechanical equipment and to have flexibility to meet changed requirements.
- Improved use of materials and construction methods to lower building costs; for example, development of the building "package" to simplify purchase and erection of the building and aid in selection and installation of its equipment.

## . . . Rural Electrification

*(Continued from page 452)*

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## EJC Proceedings

THE Engineers Joint Council's "Proceedings of the Third General Assembly" are available from EJC, 29 W. 39th St., New York, N. Y., for $1.00 per copy. Papers and discussions presented during the two-day meeting, January 17 and 18, are published in the 48-page report.

Topics of papers cover problems of the engineer in government service, the economic status of the engineer, and the impact of the engineer in international relations. High lights of some of the papers include reports on the comparison of engineers' salaries with national productivity and wages; government taking a new look at engineers, salary-wise; merit rating and position evaluation as aids to salary administration; and engineering opportunities abroad.

## . . . Erosion Control

*(Continued from page 425)*

servation practices which are necessary for efficient use of the method. At this laboratory, individual storm runoff and soil loss data from practically all such experiments in the United States, totaling over 700 plot years of data, have been placed on punch cards with related cover, rainfall, slope, and other information. Analysis of the data by multiple correlation and other statistical methods is now well under way.

Land forming is a new practice which represents a climax in engineering phases of conservation. It requires for its most effective use the best agronomic practices. While it is an established practice in many western irrigated areas, its application is now well started in the East, Midwest, and South not only for drainage improvement on bottom land areas but on level to gently rolling uplands to eliminate surface depressions that pond water during wet periods and on eroded upland areas to be reclaimed. This land-forming practice includes filling of depressions and elimination of gullies by heavy earth-moving equipment. On rolling land terracing both conventional and the modern paralleled systems are included. Land planes or levelers are used for precise grading and smoothing on these areas. The development of this program shows that power-farming equipment properly utilized increased the effectiveness of erosion control practices and the workability of the field, and, in many cases, materially increased yield.

In the Midwest, the Wisconsin station has led in land forming with development of a system of surface drainage and erosion control on land varying from flat up to slopes of 4 percent. It includes drainage-type terraces without berms, and land smoothing to eliminate surface impoundment. There have been similar developments in Missouri and Illinois.

Parallel terrace lines were something wished for but not realized until the development of modern earthmoving and smoothing equipment. A great deal of the first development and application work along this line began in Iowa about 12 years ago. More recent research in Missouri has shown this type of terracing practical on the Midwest claypan soils where the slopes seldom exceed 6 percent. It showed that point-row areas and farming time in the production of row crops were materially reduced by the new system.

In the deep Southeast where high and intense rainfall and rolling to steep topography combine to make erosion control necessary, land forming practices are being developed at several research centers. The Alabama station has been experimentally developing a system of land forming using parallel terraces to enable the use of large multiple-row equipment and thus enable lower priced land having longer seasons and more favorable rainfall to compete with more level lands. A similar development is under way at Watkinsville, Ga., where crooked terraces, gullies and other impediments to use of modern power equipment are being removed and replaced by parallel terraces and productive waterways. This work has moved forward continuously for many years as the possibilities have been studied and applications made experimentally.

In Louisiana and Mississippi, research workers are developing a rapidly spreading system of forming a suitable topography and smoothing land to facilitate an even movement and drainage of surface water. The work started with studies of drainage of sugar-cane land but is being extended to cotton and general crop sections of the Louisiana delta.

The integration of many of these practices into an applied farm program is being carried out at the Southern Piedmont Experiment Station, Watkinsville, Ga. This study includes land forming, terracing, cropping and soil treatments for efficient machinery operation, runoff and erosion control, soil improvement, and for adequate income. The use of livestock as an integral part of the farm management program to utilize the crops for greater income and more efficient use of labor is a part of the study.

Developments during this 50-year period may be summarized into *(a)* public awakening to the need for conserving our soil and water resources, *(b)* development of techniques and organization by which engineers and agronomists may apply sound and effective control measures to the land, and *(c)* initiating intensified research programs which give promise of developing more effective and economical measures for preservation of the nation's soil and water resources.

## . . . National Tractor Demonstrations

*(Continued from page 413)*

with one another. At the end of the circuit the total attendance of farmers had exceeded anything that had ever before been staged in agriculture in this same length of time.

Included were representatives from trade, technical and farm periodicals as well as the newspapers. Men from various affiliated industries, the automobile industry, agricultural leaders from colleges, Department of Agriculture and foreign countries were there. The educational and publicity impact of this campaign was almost explosive. I think it can be said that the National Tractor Demonstrations marked the beginning of power farming in America.

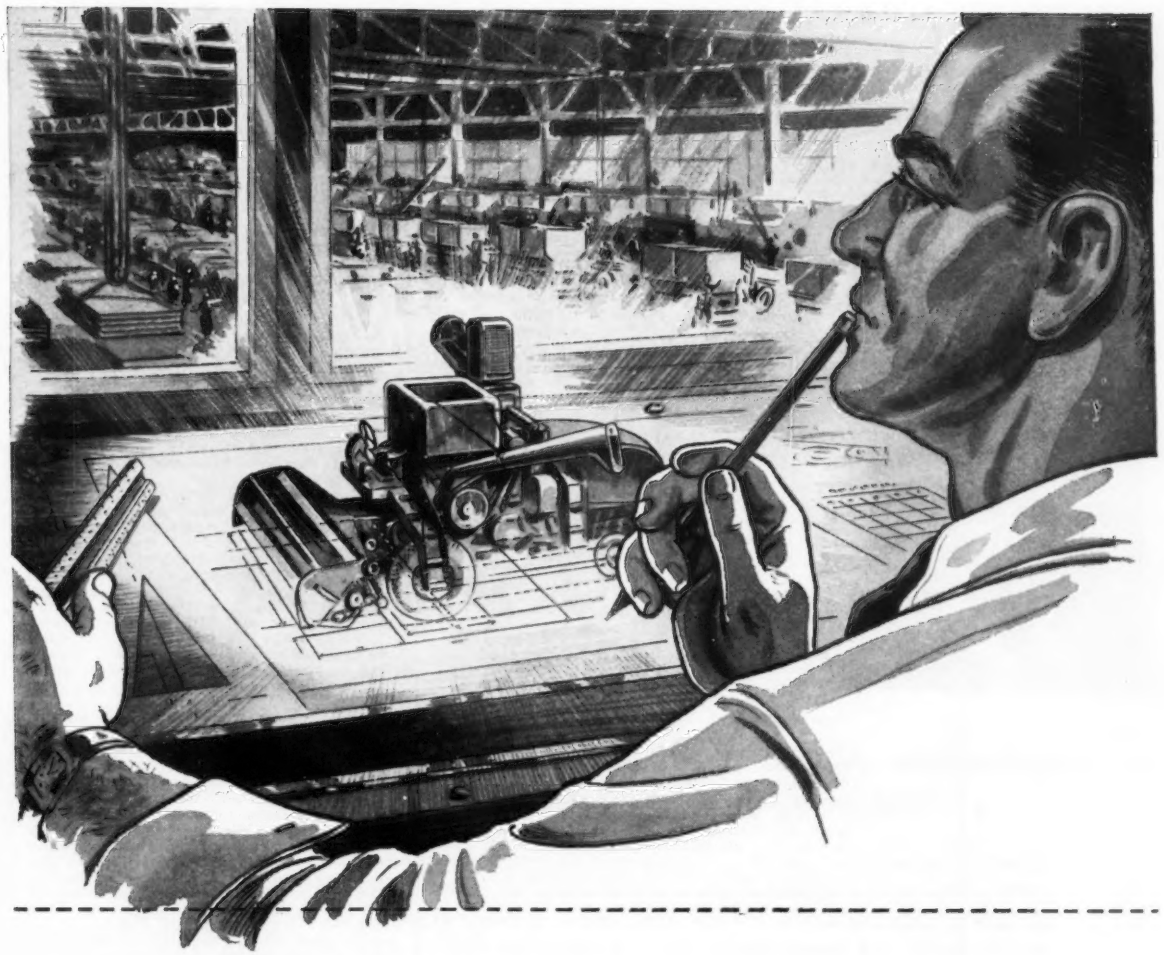
But the influence on the mechanical development of the tractor and power equipment was even more important, in my opinion. I was then engaged in the engineering end of the business and could observe this from a rather close range.

In these demonstrations an array of 30 to 40 makes and something like 200 models of tractors and every assortment of power operating equipment was on exhibit, most of it undergoing competitive demonstrations under all sorts of field conditions. Engineers, sales representatives, and company executives would spend the day going from one plot to another to study and to compare the performance of the equipment and its various mechanical features. Numerous fuel consumption tests were conducted. Here for the first time the traction dynamometer captured the imagination of the public. Drawbar pull of plows and other tools became a familiar term to farmers and the press. Wheel slippage and traction efficiency gained new importance. The overall agricultural adaptability of the tractor was given new meaning.

It is safe to say that the results of these demonstrations in 1916 advanced the engineering of tractors and power equipment by at least five years. Without this tremendous impetus, we can surmise, the tractor would have been far less ready to make its strategic contribution to solving the food problem which was critical in World War I.

Of course, Mr. Hildebrand was not the sole creator or organizer of the demonstrations but he became the manager and more than anyone else he was the one man who kept the performance going. As the representative of one of the participating companies I attended all the regional and national demonstrations from 1915 to 1917. During these years I had the opportunity to become very well acquainted with Mr. Hildebrand and to work with him. In my opinion he was the right man at the right time and in this capacity he rendered outstanding service to the industry and the nation. It seems to me, the logical source of appropriate recognition for this service is the American Society of Agricultural Engineers.

G. B. Gunlogson
Life Member of ASAE and former
president of Western Advertising Agency



# Just Where Does Invention End and Industry Begin?

THAT'S a good question—but not a difficult one.

The old idea that a product is invented, proved, and then released to production just isn't the whole truth in a large, modern, and progressive industry. Rather, the two overlap one another to an almost limitless extent. Invention in a progressive industry is continuous research and development which always keep a jump or two ahead of customer needs and a step or two ahead of production.

In a modern industry, such as the agricultural equipment industry, the "inventors" are the engineers, a group of men happily endowed with a faculty for blending the visionary and the imaginative with the factual and practical. They are a part of two industrial worlds, that of the future and that of the present.

In one sense, the agricultural engineer never completes a job. Even as he readies a new product for production, he is already searching his mind for ways to improve it or to broaden its application.

This is the modern relationship between invention and industry, making them into a congruent partnership and erasing any definite demarcation between the two.

This is the relationship between invention and industry that we like to recall as we extend congratulations to the A.S.A.E. on this its 50th anniversary.

JOHN DEERE

**JOHN DEERE**
**MOLINE, ILLINOIS**

 For more facts circle No. 30 on reply card

# President Eisenhower and Secretary Benson Elected Honorary Members of ASAE

The Council of ASAE, during the Golden Anniversary year of the Society, has elected Dwight D. Eisenhower, President of the United States, and Ezra Taft Benson, Secretary of Agriculture, to the grade of Honorary Member in the Society.

The election of President Eisenhower to Honorary Member was completed at a time when it was impossible to arrange for a formal presentation. A notice of election and a membership certificate, mailed by ASAE President Roy Bainer, brought the following letter of acceptance from President Eisenhower:

A formal ceremony in which membership was presented to Secretary Benson took place May 28 in Washington, D.C. Earl D. Anderson, ASAE president-elect and director, agricultural extension, Stran-Steel Corp., made the presentation. Statements by President-Elect Anderson and Secretary Benson are reproduced here for the particular information of Society members.

THE WHITE HOUSE
WASHINGTON

March 11, 1957

Dear Mr. Bainer:

Thank you for your letter of March fifth. I am grateful to you, and to the Council of the American Society of Agricultural Engineers, for your kindness in electing me to honorary membership in your Society, and I appreciate very much the compliment you have thus paid me.

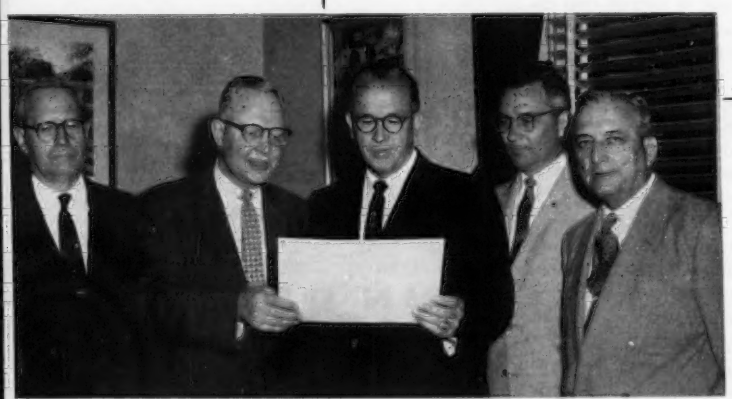
I suspect it would be better if the publications were addressed to me at the White House, since mail reaches me more regularly that way.

With best wishes,

Sincerely,

Dwight D. Eisenhower

Mr. Roy Bainer,
President,
American Society of Agricultural Engineers,
University of California,
Davis, California.



ASAE members welcome Ezra Taft Benson, Secretary of Agriculture, to honorary membership in the Society. *(Left to right)* Wallace Ashby, head, farm buildings section, AERD, ARS, USDA; President-Elect Earl D. Anderson, director, agricultural extension, Stran-Steel Corp.; Secretary Benson; J. L. Butt, secretary of ASAE; E. G. McKibben, director of Agricultural Engineering Research Division, USDA

### Presentation of an Honorary Membership Certificate of the American Society of Agricultural Engineers to the Honorable Ezra Taft Benson, Secretary of Agriculture

It is my very great pleasure, Mr. Secretary, to welcome you to membership in the American Society of Agricultural Engineers. This is a very special year for Agricultural Engineers — the 50th Anniversary of the founding of their Society in 1907. And this is a very special membership certificate bearing your name, Ezra Taft Benson, declaring you to be an honorary member of ASAE. You are among only 21 men to be so honored in our 50 years of progress.

Our members are proud of their half century of Engineering service to the Agricultural industry through developments in the four major fields — power and machinery, farm structures, electric power and processing, and soil and water. Working in cooperation with scientists in other branches of agriculture, Agricultural Engineers have contributed greatly toward reducing farm labor requirements and eliminating drudgery, making the farm a better place to work; conserving and improving the productivity of the soil, and contributing to the material well-being of the farm family.

With this proud background, it was the consensus of the Council, the Society's governing body, that an honorary membership in our Golden Anniversary year should be awarded to a man with an outstanding record of service to agriculture, a man of high integrity — a constructive leader. You, Mr. Secretary, were their unanimous choice. Therefore, in behalf of the Council and the entire ASAE membership it is my pleasure to convey to you this honorary membership certificate in our Society. We are also happy to present to you copies of the 1957 issues of the Society's Journal, AGRICULTURAL ENGINEERING.

We hope your membership in our Society will be both pleasant and profitable and we invite you to attend our 50th Anniversary meeting to be held on the campus of Michigan State University at East Lansing, Mich., June 23 to 26.

Earl D. Anderson, President-Elect, ASAE,
and director, agricultural extension,
Stran-Steel Corp., Detroit, Mich.

Washington, D.C., May 28, 1957

### Statement by Ezra Taft Benson, Secretary of Agriculture, for American Society of Agricultural Engineers

I am deeply honored by your action in admitting me to honorary membership in the American Society of Agricultural Engineers.

Engineering affects the operation of every farm in the United States and the production, processing, and marketing of every crop and animal product. Good engineering can make a farmer, while poor engineering, or lack of engineering techniques, can break him.

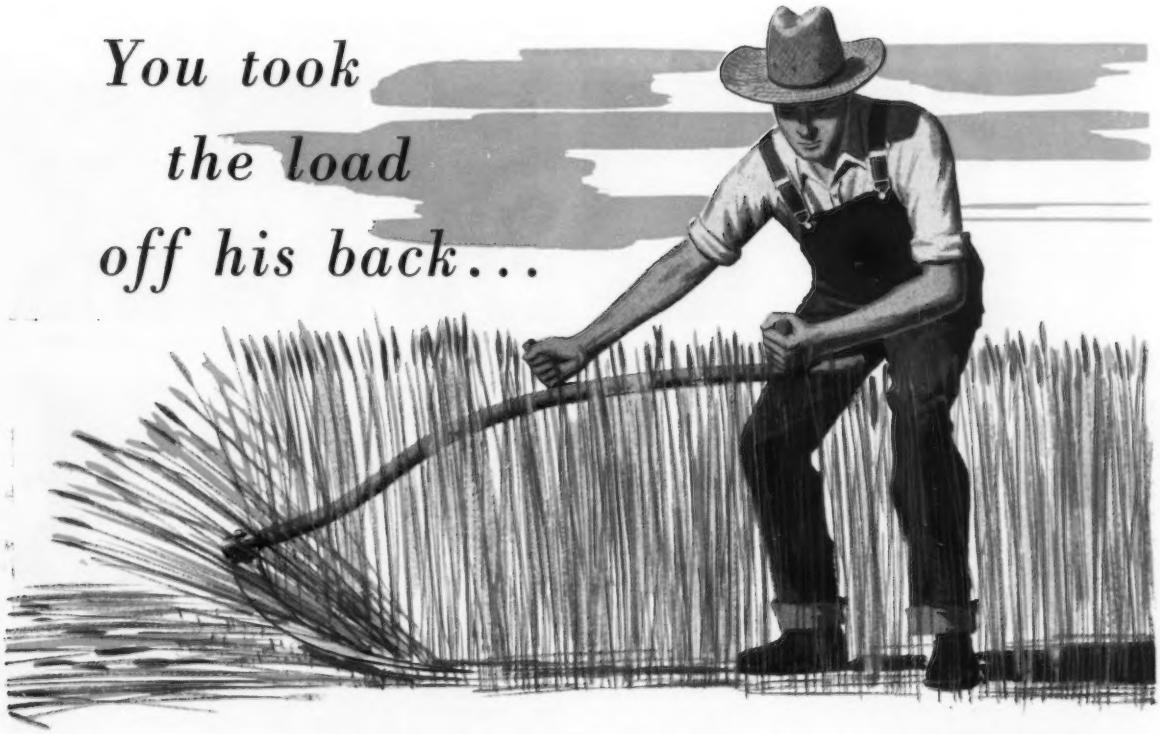
The mechanization of agriculture, aided by agricultural engineering research, has been a major factor in giving this nation the food and fiber it has required to take its place of leadership in the world.

One only needs to compare the farms of today with the farms of 1900 to realize the role mechanization has played. A farmer today produces about as much in one hour as he did in three and a half, centuries ago. There are more tractors than horses on farms today. About 95 percent of all farms are using electric power. These advances help explain why only 13 percent of our population now living on the farms can meet the food and fiber demands of the rest of us.

The future need for agricultural engineer-

*(Continued on page 482)*

*You took the load off his back...*



**CONGRATULATIONS TO A.S.A.E. MEMBERS ON 50 YEARS OF ACHIEVEMENT!**

ASAE

Since 1907

Your ingenious blending of science and mechanics, replacing muscle with mechanical power, has raised the farmer from drudge to businessman. You have helped him control his economic destiny, added billions of dollars to his worth in land and crops, and opened up a great new future for the agricultural industry.

FEDERAL Mogul

Since 1899

The development and production of improved bearings, to assure increasing dependability and economy in power units for farm equipment, has been our specialized interest. Today millions of Federal-Mogul bearings bring this dependability to farmers everywhere. Continuing research will bring new bearing products for the power units of the future.

**FEDERAL-MOGUL DIVISION**

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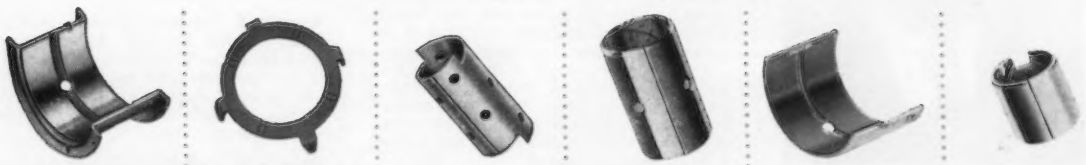
11081 Shoemaker, Detroit 13, Michigan



BABBIT-LINED BEARINGS | BEARING-SURFACED THRUST WASHERS | SPACER TUBES | BIMETAL BUSHINGS | COPPER-LEAD BEARINGS | ROLLED SPLIT BUSHINGS

**RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING**

**John S. Adams,** assistant chief engineer of the Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., at Lancaster, Pa., since 1956, has been named chief engineer to succeed A. R. Spicacci, who resigned to become a consultant.

Mr. Adams is a native of Lancaster. He attended Franklin & Marshall College and M. I. T., graduating in 1947 with a B.S. degree in mechanical engineering. In 1948 he received a B.S. degree in business and engineering administration from M.I.T. He became associated with BCA in 1948.

**Jack R. Schram** has been appointed manager, sales training dept., Tractor and Implement Division, Ford Motor Co. He was born in Covington, Ohio, and graduated from Ohio State University with B.S. degrees in agriculture and agricultural engineering. After three years of military service, he became an instructor in the agricultural engineering dept. of Michigan State University. In 1949, he accepted a position with Dearborn Motors Corp.

He joined Ford Motor Co. in 1953, as product training supervisor for the Tractor and Implement Div., later serving as a sales representative in the Memphis regional sales office and as a sales analyst at the general offices in Birmingham, the position he held at the time of his promotion.

Mr. Schram is past-president of the Michigan Section of ASAE, and has been a member since 1948.

J. S. Adams

J. R. Schram

L. G. Samsel

E. A. Hardy

**L. G. Samsel** has been promoted to supervisor of films, exhibits, and photography of the J. I. Case Company. He has spent most of his business career in the advertising department of the company, first as an editor of product literature and recently as editor of educational material.

**Robert W. Kleis** has resigned from the staff of the University of Illinois to accept a position as professor of agricultural engineering and head of the department at the University of Massachusetts.

He served at the University of Illinois from 1951 to 1956, teaching and doing research in rural electrification and processing. Prior to that he was instructor in agricultural engineering, Michigan State University. He has recently completed the Ph.D. degree in agricultural engineering at MSU.

**Pier Francesco Talenti** has been promoted to assistant cashier of the First Western Bank and Trust Co. in San Francisco, Calif. A native of Rome, Italy, he joined First Western in 1955, and was serving as consulting engineer at the time of his promotion. Before entering the banking field he was engaged in land development and reclamation work in Rome.

He attended the University of Rome, received an M.S. degree in agricultural engineering from the University of California (Davis), and earned degrees in civil and rural engineering from the I.T.S. school in Fribourg, Switzerland.

R. W. Kleis

P. F. Talenti

**Evan A. Hardy,** agricultural engineering advisor, FAO Technical Assistance Mission, Department of Agriculture, was awarded an honorary degree LLD from the University of Saskatchewan. This honor is in recognition of his years of service in the field of agricultural engineering.

He was born in Sioux City, Iowa, and received a B.S. degree in agricultural engineering from Iowa State College in 1917, and an M.S. degree in 1922. After graduation he accepted a position as instructor at the University of Saskatchewan. He continued at the University for 31 years eventually becoming head of the agricultural engineering dept. During his time at the University of Saskatchewan, he instituted many forms of extension services.

In 1953 he obtained leave of absence and joined the FAO as technical advisor and was sent to Ceylon. He has been in Ceylon acting in various capacities with the technical assistance program since that time.

**George C. Merkel** has been named city engineer of Grinnell, Iowa. He will be responsible for planning and supervising all city engineering projects.

Formerly he was general manager of Powershiek Steel Buildings Co. in Grinnell. At one time he worked in northern Missouri and southwestern Iowa as an engineering specialist with the SCS.

**Russell E. Heston,** formerly assistant secretary of the National Association of Mutual Insurance Companies, Indianapolis, Ind., has been appointed associate professor in the agricultural engineering dept. of the University of Illinois. His work is in the farm electrification area.

**George E. Pickard,** professor, agricultural eng. dept., University of Illinois, and family have returned from a six-month stay in the Hawaiian Islands. He was on sabbatical leave serving as engineering consultant with the Hawaiian Sugar Growers Assn.

## NECROLOGY

**J. Brownlee Davidson,** charter member, honorary member, and first president of ASAE, and professor emeritus of agricultural engineering, Iowa State College, died May 8 at his home in Denver, Colo.

J. Brownlee Davidson

The name "J. Brownlee Davidson," has been synonomous with the words, "agricultural engineering." To some, Dr. Davidson was thought of as the "father of agricultural engineering" because for over fifty years he devoted his life to the development of agricultural machines and methods. Both the government and private industry relied upon his judgment and followed his recommendations. He was one of the nation's leading contributors to the field of agricultural engineering.

Born in 1880, Dr. Davidson was brought up in Douglas, Nebraska, and graduated from the University of Nebraska in 1904 with a B.S. degree in mechanical engineering. His alma mater awarded him the degrees Agricultural Engineer in 1914 and Doctor of Engineering in 1931. He began his professional career with industry, but shortly made the decision to accept employment on the staff at the University of Nebraska teaching farm mechanics. The following year he went to Iowa State College as an assistant professor and was rapidly promoted to full professor and head of the agricultural engineering department.

He was instrumental in the founding of the first agricultural engineering departments in the country and the American Society of Agricultural Engineers. He served as the Society's first president, and helped start its technical journal.

In 1926 Dr. Davidson served as director of a survey on research in mechanical farm equipment for the U.S. Department of Agriculture. In 1929, he was a member of an

*(Continued on page 484)*

The good name of your machine is LINK-BELT's first consideration . . . TRADE MARK . . . and quality should be your first consideration in the chain you buy

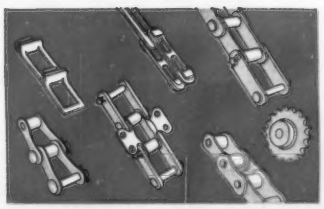
NEW IDEA No. 300 2-row pull type corn picker which uses Link-Belt "AG" roller chain, steel detachable Link-Belt and "RC" couplings.

# Is the chain you use as good as the machine you make?

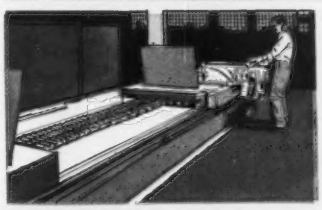
## Here's how LINK-BELT matches drive and conveying chain to the field requirements of your equipment

THE Link-Belt double-arrow trademark ⟩——⟨ on chain means that each link in every length conforms to rigid quality and uniformity specifications. And it's your assurance that the drive or conveyor chain specified will maintain rated performance and efficiency on your machine.

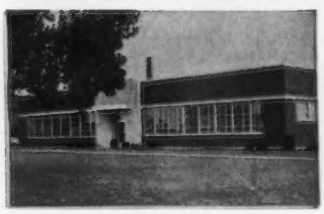
From the world's largest chain plant, Link-Belt offers you the economies of mass-production . . . represents a ready source for all your chain and sprocket needs. For prompt service, call your nearby Link-Belt office. 14,614



COMPLETE LINE of agricultural chains, sprocket wheels and attachments permits cost-saving specialization — offers right chain for all conveyor and drive needs.



ACCURATE MANUFACTURE AND CONTINUOUS INSPECTION with modern, specialized machines allow economies of large-scale production. Extensive facilities provide ample capacity to meet your production schedules.



LABORATORY CONTROL assures you that each chain meets rigid uniformity specifications. Our modern laboratory continuously explores new refinements to increase chain life.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

# HOW TDA®
## HELPED PUT MORE "DRIVE" INTO POWER FARMING!

This newest of self-propelled combines represents another great forward step in power farming—thanks to the teamwork of one of America's largest manufacturers of farm equipment and Timken-Detroit® Axle.

Completely new from top to bottom, this 10-foot combine offers new convenience, easy control—and a totally new, specially-designed TDA driving assembly that permits changing ground speed on-the-go without touching the throttle, or affecting the separator speed.

Field proved under many conditions in South America, Mexico, and here—this new combine will harvest all grains—soy beans, alfalfa, wheat, and corn, the latter with a special header unit.

Once again, Timken-Detroit experience, research and engineering ability have helped another farm equipment manufacturer solve another design problem . . . build a better product. If you have a problem in designing or building driving assemblies for farm equipment, call in Timken® engineers. It costs you nothing—and will save you money in the long run.

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Plants at: Detroit, Michigan
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Ashtabula, Kenton and Newark, Ohio
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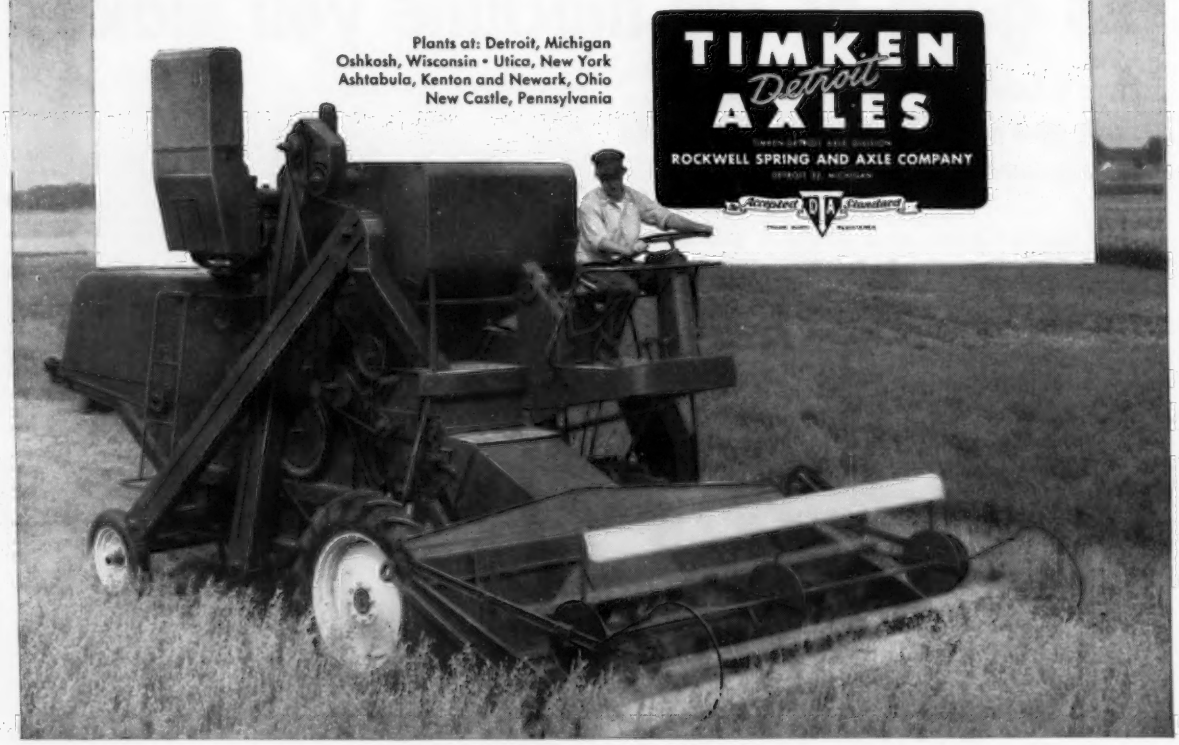
ROCKWELL SPRING AND AXLE COMPANY
Accepted TDA Standard



# NEW

## Tachometer Take-Off

## ...for VEEDER-ROOT Rev-Counters

With this new attachment, Veeder-Root Rev-Counters can be installed on any engine having a tachometer take-off in a position which is readily accessible for easy reading. Take-off can be furnished to suit average engine-speed.

So now you can make it easier than ever for your customers to see that your product is performing up to its guarantee . . . to see when routine maintenance is coming due, and whether servicing is needed.

You can count on Veeder-Root to figure out how to engineer these adaptable Rev-Counters into *your* products . . . not only engines, but generators, compressors, heaters, refrigerators, and what have you? Write:

*Everyone... Can Count on*

**VEEDER-ROOT**
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# Here's the FARM MOTOR YOU ASKED FOR...
## designed from test information on actual farm installations

Openings in the motor are screened against rats and mice.

Rugged cast-iron shell is painted inside and outside. Windings treated to resist moisture.

End hoods treated inside and outside to resist rust and corrosion. Screened against rats and mice. Aluminum, copper and stainless steel or bronze brushholder parts resist corrosion.

Ruggedly constructed armature is dynamically balanced. No short circuiting mechanism.

### REPULSION-INDUCTION

For farm applications where low voltage is a problem. Will operate at extremely low voltages without harm to the motor. No short circuiting mechanism to cause trouble. Brushholder parts of aluminum, copper, stainless or bronze to resist corrosion. Built-in manual reset type thermal overload protector prevents burnouts. Windings, hoods and shells treated to resist corrosion and moisture. All openings screened against vermin.

RECOMMENDED FOR: silo unloaders, barn cleaners, milking machines, feed grinders, ensilage cutters, elevators and conveyors.

### CAPACITOR

Best suited for applications where equipment operates continuously. Few parts to cause trouble. Cast iron shell and end hoods treated inside and out to resist rust and corrosion. Windings treated against moisture. Completely screened against vermin. Heavy-duty, double-contact starting switch. Capacitor in terminal box for easy replacement.

RECOMMENDED FOR: ventilating fans, crop dryers, grain and hay blowers, irrigation pumps, conveyors, refrigeration compressors and other continuous-duty applications. Peerless will work with you to create the one motor that meets your needs best.

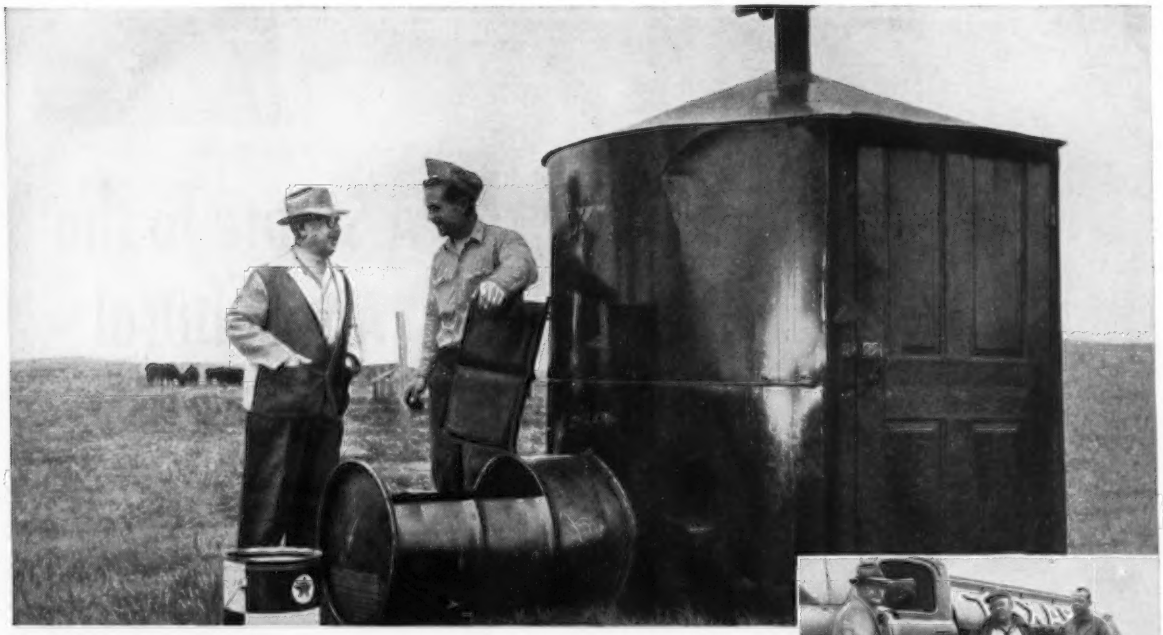
*For further information write for Farm Motor Bulletin*

ELECTRIC MOTOR DIVISION

THE Peerless® Electric COMPANY

FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT

1522 W. MARKET ST. · WARREN, OHIO



## HE BUILT A UNIQUE SMOKEHOUSE!

Texaco Consignee R. J. Davis admires the ingenious smokehouse constructed by Rod Breaux, who farms 850 acres near Welsh, La. He simply put together an abandoned water tank, a door from an old house, and an empty Texaco oil drum to contain the wood fire. Cost practically nothing, and turns out delicious smoked meats!

Mr. Breaux is the inventor of several labor-saving devices to make operation of his big farm easier and more economical.

Mr. Davis has been a Texaco Consignee for 39 years, and has a steady customer in Mr. Breaux, who has found that *it pays to farm with Texaco products.*

**TEXACO FIRE CHIEF GASOLINE,** with superior power for low-cost operation is supplied to farmers around Orangeburg, S. C., by Texaco Consignee G. P. Gilbert, shown here with L. L. Griffith of the Caw Caw plantation and B. A. Gilbert. The Gilbert brothers are well liked for their dependable, neighborly deliveries.

**MARFAK LUBRICANT** is delivered regularly by Texaco Consignee Vance Hutchison to Johnnie Walden, farmer of Enterprise, Ala. Mr. Walden agrees that Marfak is superior because it won't drip out, wash out, dry out or cake up – adds to the life of farm machinery and prevents repair bills. Marfak lubricated bearings can *take* it!

**FOR 27 YEARS** Texaco Consignee J. Ben Chase has been supplying the 2600-acre Goldman Plantation, Goldman, La., with Texaco products exclusively. H. T. Goldman, Jr. (right) has found that Advanced Custom-Made Havoline Motor Oil wearproofs truck and tractor engines – gives added power and longer engine life.

**IN TOWN OR ON THE HIGHWAY** – in all 48 states – there are Texaco Dealers with top-octane Texaco Sky Chief gasoline, supercharged with Petrox, for maximum power and to cut engine wear, and Texaco Fire Chief gasoline at the *regular* price, both 100% *Climate-Controlled* . . . Havoline Motor Oil and Marfak lubricant.

**ON FARM AND HIGHWAY IT PAYS TO USE**

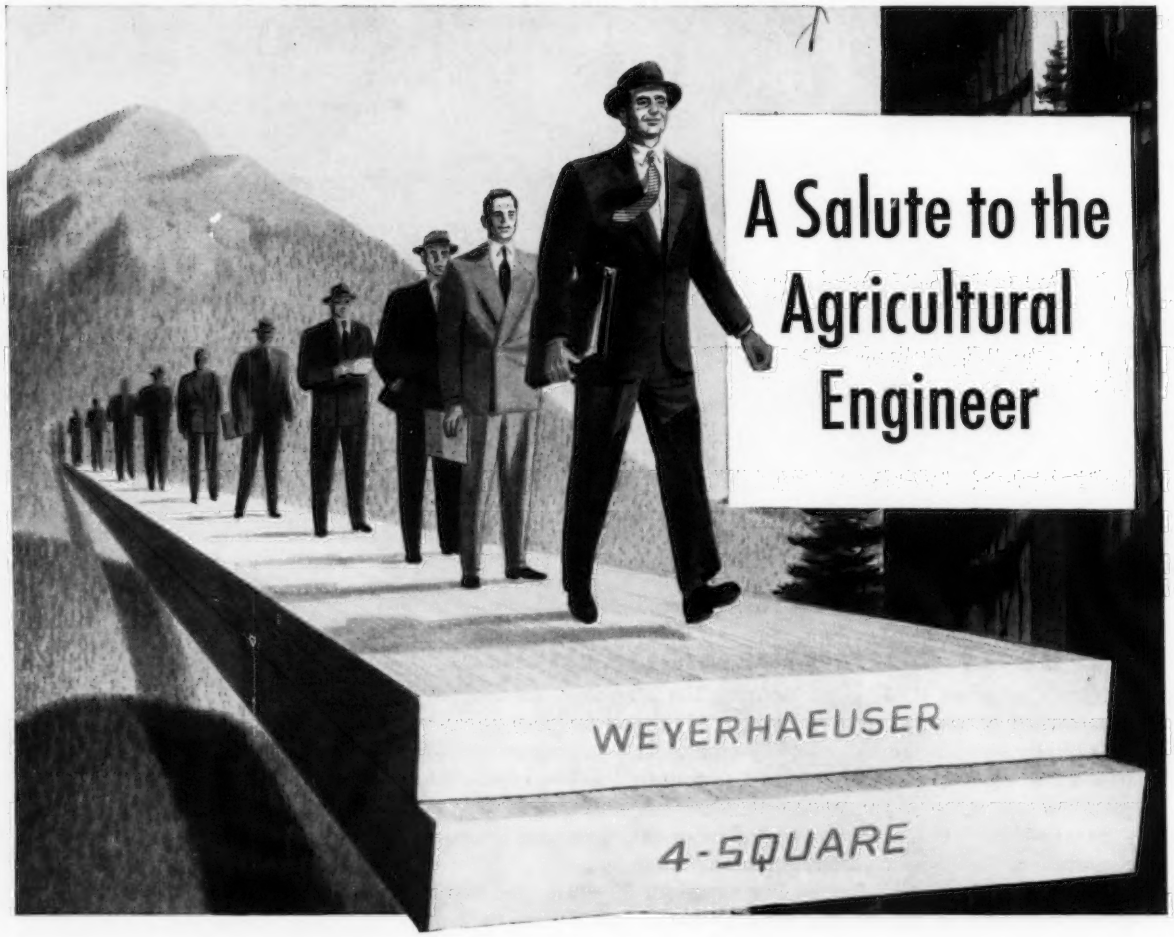
# TEXACO

**PRODUCTS**

**DIVISION OFFICES:** Atlanta, Ga.; Boston 16, Mass.; Buffalo 9, N. Y.; Butte, Mont.; Chicago 4, Ill.; Dallas 2, Tex.; Denver 3, Colo.; Houston 2, Tex.; Indianapolis 1, Ind.; Los Angeles 15, Calif.; Minneapolis 3, Minn.; New Orleans 16, La.; New York 17, N. Y.; Norfolk 2, Va.; Seattle 1, Wash.

**Texaco Products are also distributed in Canada, Latin America, and Africa.**

THE TEXAS COMPANY




Once in awhile we hear someone talk about the "typical" Agricultural Engineer.

When we hear that phrase, we stop listening. We don't believe there is a "typical" Ag Engineer. Every one we have known has been his own man. He has his own field of interest, his own methods of experimentation, his own ideas.

In short, he is an individual . . . with a quiet pride in his profession.

But Ag Engineers do have a common denominator . . . Service. Wherever we find an Ag Engineer (and we have run across them in some unusual places), we find a man who is putting all his talents to work, seeking ways to better serve the people along the agricultural lifeline.

It is a job that calls for all the technical skill and creative ability a man can offer. It is always hard work. Sometimes the challenges seem insurmountable. But it is gratifying work that pays dividends in the satisfaction a man gets from successfully completing a difficult task.

It is work that demands a special kind of man. That is why the Ag Engineer rates high at Weyerhaeuser. We respect him, we value our relationship with him. We stand ready to help him when we can.

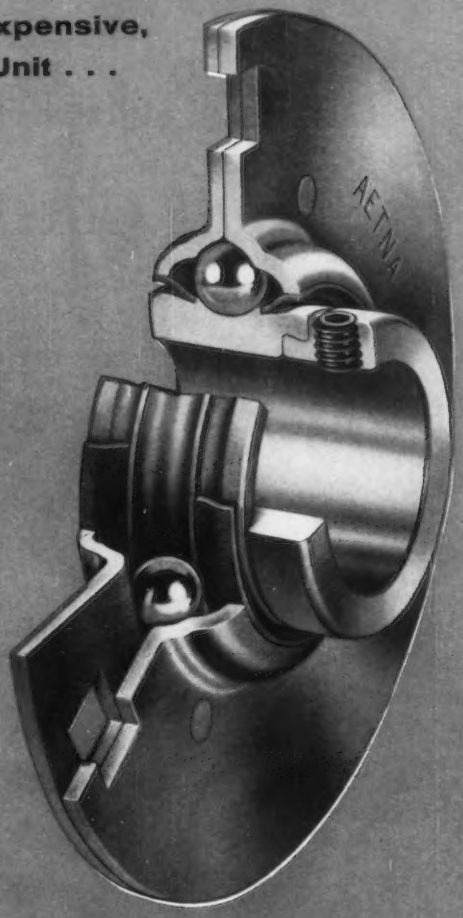
Weyerhaeuser is a pioneer in the Farm Structures Field. The Weyerhaeuser 4-Square Farm Building Service is one of the most complete building idea sources available to farmers. We think some of our ideas might help you with your work. We'll be happy to mail you free booklets showing a selection of the building and equipment items featured in our 4-Square Farm Building Service.

**Weyerhaeuser Sales Company**

P.O. Box 5000, Dept. D-67

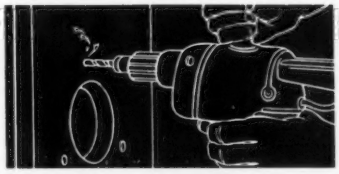
ST. PAUL 4, MINNESOTA

**This Aetna Adapter Bearing is inexpensive, comes in a compact PACKAGE Unit . . . and talk about easy installation—**



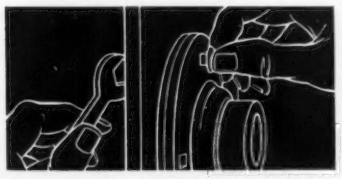

## IT'S AS SIMPLE AS THIS:

A



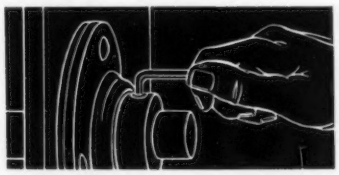
Drill (or punch) 3 bolt holes in shaft supporting member.

B



Place Adapter unit in position, insert bolts and tighten nuts.

C



Install shaft, twist locking collar, tighten set screws.

**And there you have it—**

**—all the advantages of ball bearing efficiency adapted to your current or projected equipment designs with minimum, or no engineering alterations.**

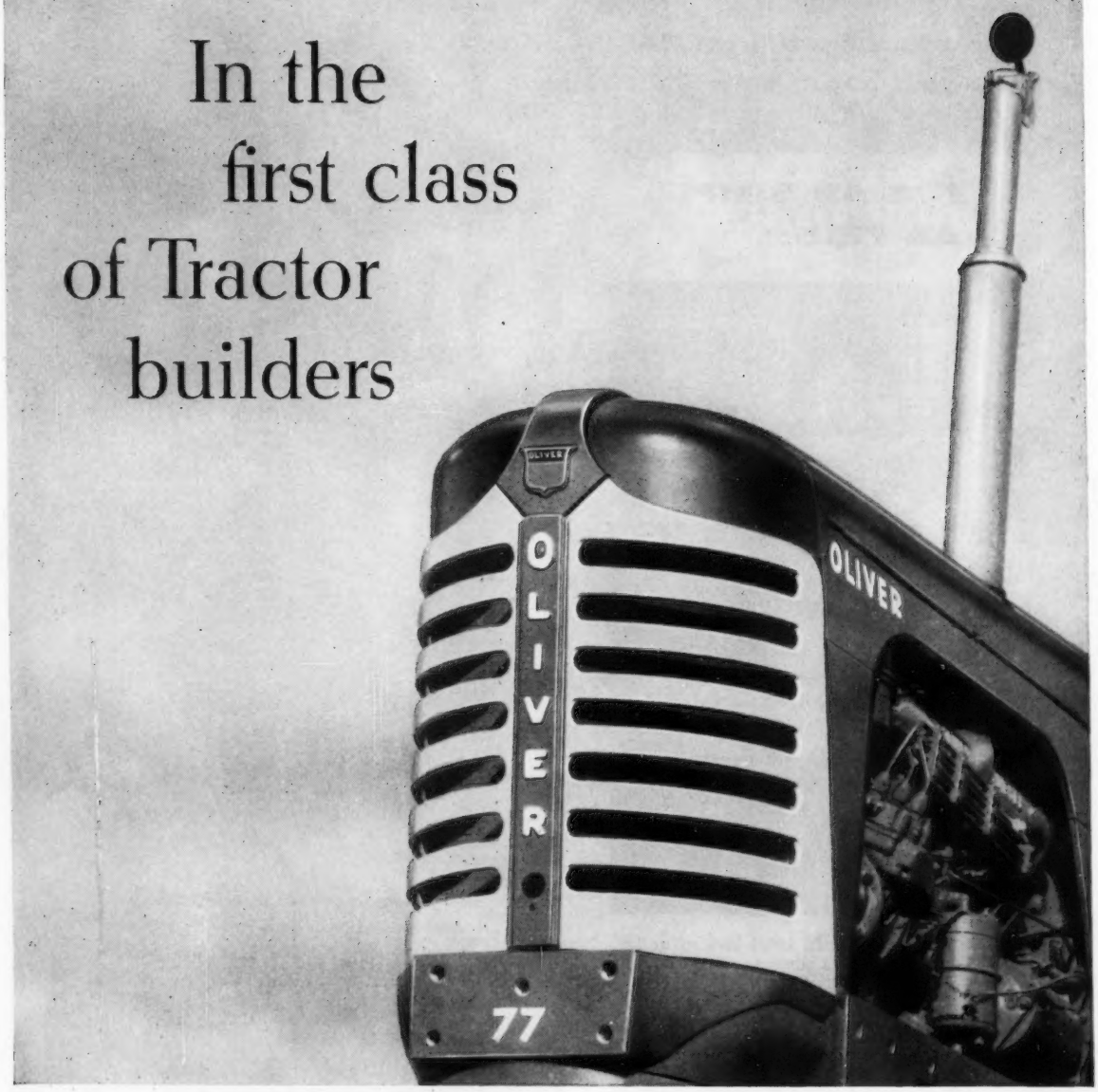
**Designed and built-to-be-installed-and-forgotten this permanently lubricated, sealed-for-life Adapter bearing requires no re-lubrication, no maintenance of any kind. It combines self-aligning bearing, seals, mounting flange and locking collar in a single easy-to-handle package assembly that mounts wherever shafts can be supported—including sheet metal or any semi-rigid structural members. Available in a range of standard shaft sizes. Write us or call in our local expert, your nearby Aetna distributor.**

**AETNA BALL AND ROLLER BEARING COMPANY**

DIVISION OF PARKERSBURGH-AETNA CORPORATION • 4600 SCHUBERT AVE. • CHICAGO 39, ILL.

**Aetna** Anti-friction Consultant to Leading Original Equipment Manufacturers since 1916

# In the first class of Tractor builders




Since the earliest days of the tractor Oliver has been among the country's most prominent builders.

In fact, many of the major farm power developments have come from Oliver's Charles City, Iowa, plant where successful gasoline tractors were first built more than 50 years ago.

Oliver was first to introduce the efficient, streamlined tractor so familiar today... first with a full fleet of 100% diesels. Recognizing the need for speed and economy, Oliver was first to team a high-compression 6-cylinder engine with a multiple-gear transmission.

Oliver was the nation's first manufacturer to equip tractors with a completely independent power take-off and first to think of the farmer's comfort and safety. Along came the rubber torsion-spring seat and a special brake-equalizing device.

That's only a part of the story. The evolution of tilling, planting and harvesting equipment during the past century includes a long list of significant Oliver "firsts." In the years ahead, too, it is Oliver's aim to contribute to the ever improving design of American farm machines.

The Oliver Corporation, 400 West Madison Street, Chicago 6, Illinois.

OLIVER OLIVER

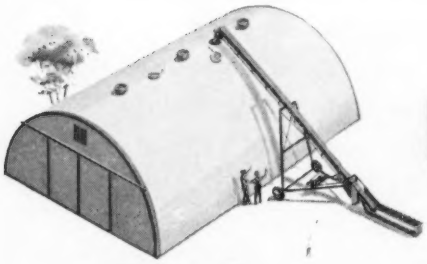
"FINEST IN FARM MACHINERY"

# STRAN-STEEL and AGRICULTURAL ENGINEERS— PARTNERS IN FARM PROGRESS

The rapid development of new farming practices has challenged America's top agricultural engineers to design more efficient farm structures. Through exhaustive research and engineering know-how Stran-Steel has answered this challenge with the Stran-Steel Farm Building Line, the most productive group of "working tools" ever built.

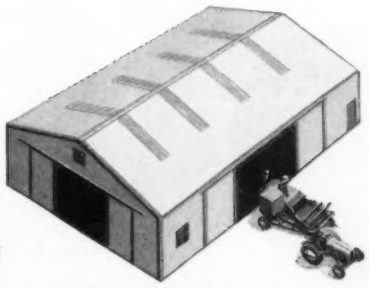
Every steel building of this profit-boosting line is tailored to the specific needs of today's farmers, yet each is completely adaptable to meet the anticipated requirements of the even greater farming advances which lie ahead.

From every angle—initial cost, upkeep, long life, appearance—Stran-Steel farm buildings are the farmer's best buy. Stran-Steel educational booklets on dairy, loose housing, stall barns, farm service and repair centers, and the buildings catalog available on request.



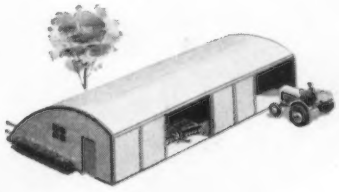
**QUONSET 40**

Quonset (*unheated air*) Grain Drying System, a product of engineering research, lets farmers choose a favorable market and realize the full advantages of early harvest. Drying costs are held to a minimum.



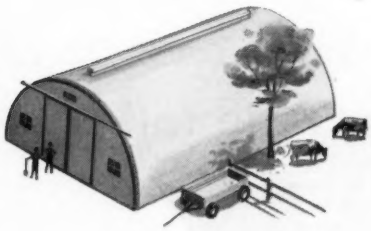
**RIGID FRAME BUILDINGS**

The Stran-Steel Farm Service and Repair Center protects farm machinery investment by providing service facilities for regular maintenance to avoid breakdowns.



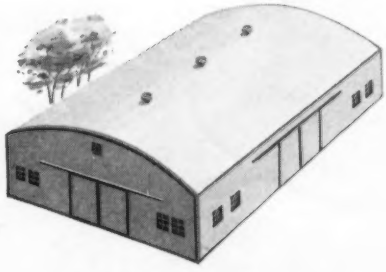
**QUONSET SPECIAL 24**

Double-duty building with side access design permits speedy in-and-out travel of machinery . . . meets all the requirements for livestock housing and feeding operations.



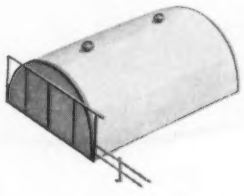
**QUONSET 32**

Planned for use as either stanchion or loose housing dairy barns. Post-free interior permits complete freedom for inside arrangements. Expands easily with herd size.



**BOW TRUSS**

Designed for low cost per bushel storage of big-acreage, large-volume farmers and ranchers. Skillfully engineered cooling system keeps grain extra safe during entire storage period.



**QUONSET 20**

Here's a building designed with real utility. It's ideal for small stock pen space and for storage of feed, seed, fertilizer and countless other farm or service supplies.

**EASY TO FINANCE**

*The Stran-Steel Purchase Plan gives you confidential financing with your dealer. Keeps bank credit free. As little as ¼ initial payment, five years on the balance, timed to income periods.*

Stran-Steel

**STRAN-STEEL CORPORATION**
**Detroit 29, Michigan • Division of**
**NATIONAL STEEL CORPORATION**

**HERE'S WHERE YOU CAN GET MORE INFORMATION: Atlanta 3, Ga.,** 206 Volunteer Bldg., **JAckson 4-6611 • Chicago 6, Ill.,** 205 W. Wacker Dr., **Financial 6-4950 • Cleveland 16, Ohio,** 20950 Center Ridge Rd., **EDison 1-3834 • Detroit 29, Mich.,** Tecumseh Rd., **Vinewood 3-8000 • Houston 5, Texas,** 2444 Times Blvd., **JAckson 6-1628 • Kansas City, Mo.,** 6 East 11th St., **BAltimore 1-8892 • Minneapolis 4, Minn.,** 708 S. 10th St., **FEderal 9-8875 • New York 17, New York,** 405 Lexington Ave., **Murray Hill 6-1400 • San Francisco 3, Calif.,** 1707 Central Tower Bldg., **DOuglass 2-1200 • Washington 6, D. C.,** 1025 Connecticut Ave., N.W., **EXecutive 3-4214**

Golden Anniversary
1907 ASAE 1957
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS



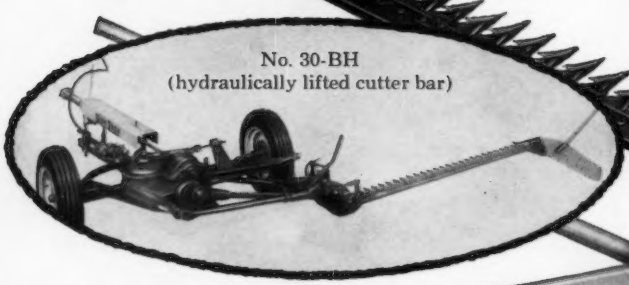
For more facts circle No. 41 on reply card

# LOOK *at the*

## NEW IDEA *No. 30-B full trailing mower*

### *. . . the original full trailing mower with exclusive* NEW IDEA *features*

No. 30-B
(mechanically lifted cutter bar)



No. 30-BH
(hydraulically lifted cutter bar)

Known as the fastest on-and-off mower on the market, this original full trailing mower, imitated but never duplicated, has been improved again for even better mowing! The new No. 30-B mower includes a simplified hitch, snap-on PTO connection, permanent type safety shielding, and retains the well known high quality NEW IDEA features that tens of thousands of farmers have proven valuable in cutting millions of acres of hay. It trails perfectly, makes square turns, mows efficiently when going is toughest.

## Check this box score!

Here are the features that will SELL the No. 30-B

- FITS ANY FARM TRACTOR
- EASIEST ON AND OFF
- CUTTER BAR CAN BE LIFTED BY PTO POWER OR HYDRAULIC POWER
- PRECISION BUILT GEAR DRIVE
- HEAVY DUTY (¾") CUTTER BAR WITH 9 HOLD DOWN CLIPS AND WEAR PLATES
- HEAVY DUTY SEMI-ROCK GUARDS ARE STANDARD EQUIPMENT
- PERMANENT TYPE SAFETY SHIELDING
- SNAP-ON PTO CONNECTION
- TRAILS PERFECTLY
- MAKES SQUARE TURNS EASILY

*PTO power lifts cutter bar. One pull on the rope lifts the bar. A second pull lowers it.*

*The only full trailing mowers with precision built gear drive, for powerful cutting action.*

*Knife easily installed. Pitman straps opened and closed by a special cam arrangement.*

*Hardened fly wheel crank pin operates in a needle roller bearing for extra long life.*

**For more facts circle No. 42 on reply card**

**NEW IDEA FARM EQUIPMENT COMPANY**
COLDWATER, OHIO, U. S. A.
Dept. I-47
AVCO DISTRIBUTING CORPORATION
DIVISION

**Caterpillar D 9 Tractor... 320 flywheel horsepower:** Nickel alloy steels provide dependable strength for heavily stressed gears, shafts and other vital parts. Built by Caterpillar Tractor Co., Peoria, Illinois.

## In 30-ton crawler

# Nickel Alloy Steels Provide Stamina, Simplify Production Problems

The D 9 is a big tractor, for big jobs . . . pulling a giant Towner disk plow on a farm in California . . . pioneering a road for a Thruway in New England. And, like other Caterpillar machines, this 30-ton crawler depends for its stamina on the strength and toughness of nickel alloy steels.

Shafts – for the belt pulley, in the clutch and in the transmission – are 8600 type steel, through-hardened. Gears – in the main drive and for the power take off – are 8600 steel, carburized.

*The same basic nickel-chromium-molybdenum composition satisfies requirements for both through-hardened and carburized parts.*

This is important for cutting production costs. Standardizing on one alloy steel for many parts simplifies production . . . eliminates complicated scheduling . . . assures high and efficient output.

Of course, these parts need high strength and toughness to take shock loading, to withstand high tooth stress in gears and high torsional stress in shafting. And 8600 steel provides these desired mechanical properties. Today tractors require fewer adjustments, fewer part replacements.

Nickel alloy steels can help you, in your product, in your production. And Inco engineers will be happy to work with you in the selection of materials.

INCO TRADE MARK THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N.Y.



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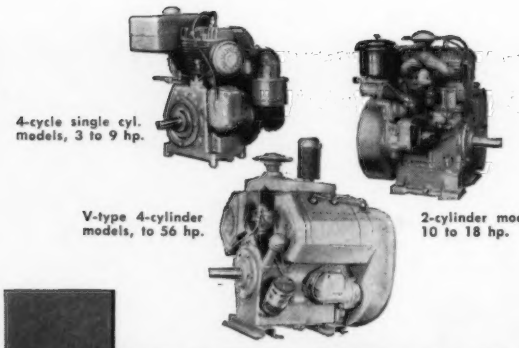
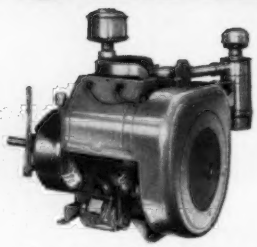



# Torque Champs




**WISCONSIN ENGINES**

*3 to 56 h.p.*

*Load-Holding Lugging Power!* That's what you get when you specify Wisconsin Heavy-Duty Air-Cooled Engines . . . engineered for HIGH TORQUE performance. Here is power that *hangs on* through the shock loads . . . and *carries on* under either variable or constant-load operating conditions.

Wisconsin basic HIGH TORQUE design pays off in terms of "Most hp. Hours" of on-the-job heavy-duty service, at all temperatures from low sub-zero to 140° F. Team-up your equipment with Wisconsin HIGH TORQUE Champs — backed by over 2,000 Wisconsin Authorized Service Stations, world-wide. Write for full-line "Spec" Bulletin S-212.

**WISCONSIN MOTOR CORPORATION**

*World's Largest Builders of Heavy-Duty Air-Cooled Engines*

MILWAUKEE 46, WISCONSIN

**For more facts circle No. 71 on reply card** A7-6103-1/2V



## AGRICULTURAL ENGINEERS YEARBOOK

•

*Copies of the 1957 edition of*

AGRICULTURAL ENGINEERS YEARBOOK

are available at $5.00 per copy postpaid.

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Contents includes (1) ASAE-Approved Standards, Recommendations, and Engineering Data; (2) Directory of Suppliers to Agricultural Engineers; (3) Roster of ASAE Members; (4) List of ASAE Officers, Divisions, Sections, and Committees.

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*Send order with remittance to*

**American Society of Agricultural Engineers**

**St. Joseph, Michigan**



## *Report on Evaporation and Evapo-transpiration*

**Research in the United States and Other Countries**

• *By John R. Davis*

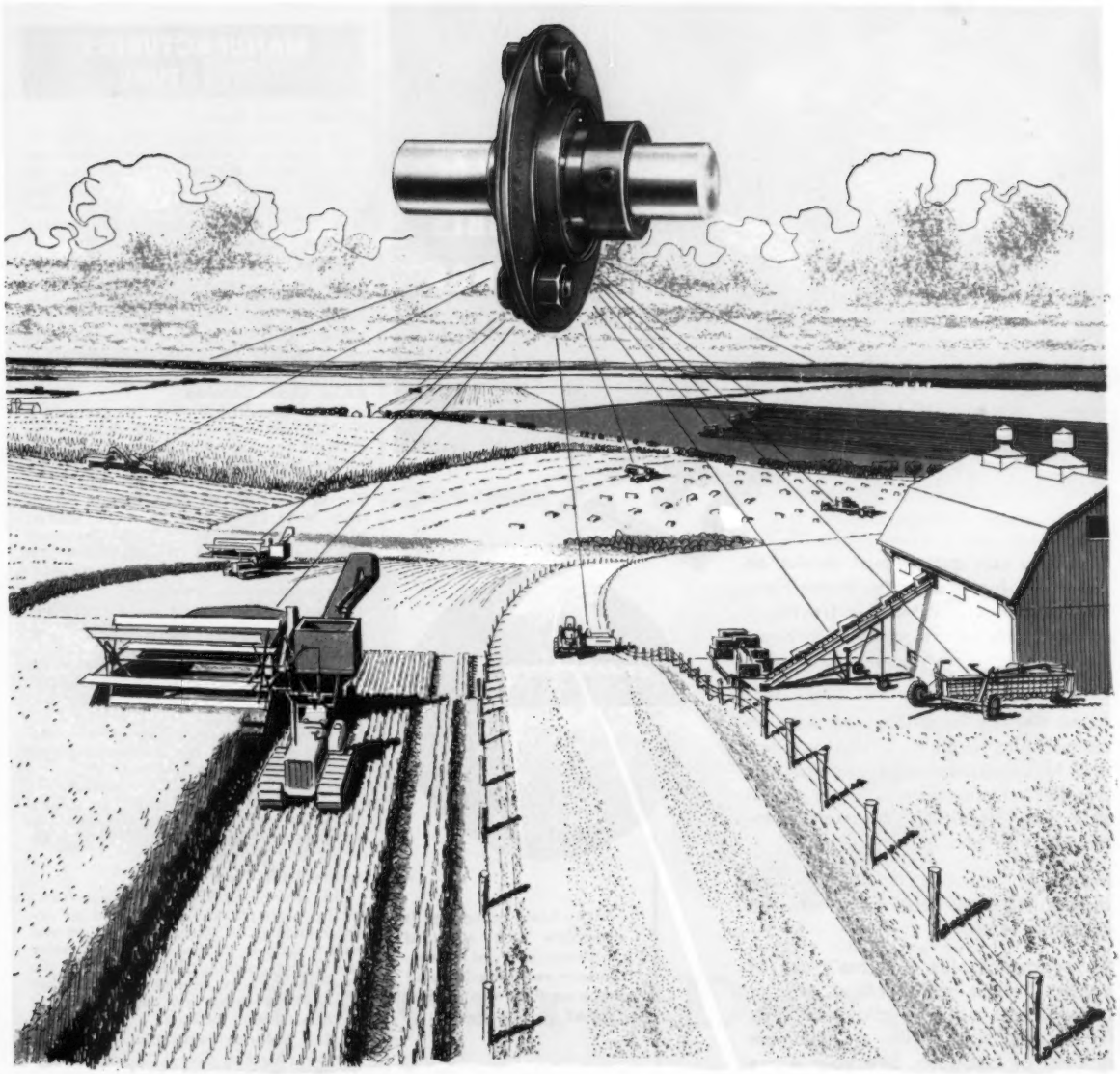
The 87-page report contains information on individual evaporation and evapo-transpiration research projects including number and title of project, cooperating departments and agencies, project personnel, project description, status of project, results and publications. Data was obtained from nearly every state and federal agency in the United States and some foreign countries.

**$1.00 per copy postpaid.**

*Send order with remittance to*

**American Society of Agricultural Engineers**

**St. Joseph, Michigan**



# An idea that started the ball rolling for more efficient farm equipment

A trend to much wider use of anti-friction bearings on farm equipment was started within the past decade by the Fafnir-originated Flangette, a low-cost, self-contained ball bearing unit. This new idea in completely "packaged" ball bearings broke the cost barrier. It was economical to mount, self-aligning on mounting, and adaptable to many types of applications. Today the Flangette is a standard component on thousands upon thousands of farm machines from conveyors to combines. To satisfy demands for various uses, it is made in three different shapes and equipped with either Plya-Seals (contact-type) or Mechani-Seals (slinger-type). The Flangette is one of several types of Fafnir ball bearing units helping to increase the efficiency and service life of modern farm machinery. The Fafnir Bearing Company, New Britain, Conn.

**FAFNIR** MOST COMPLETE LINE IN AMERICA

**BALL BEARINGS**



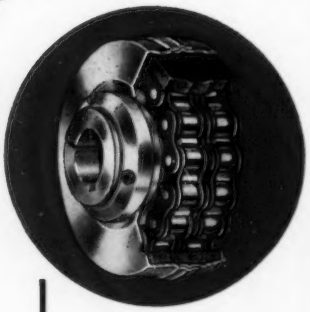
For more facts circle No. 62 on reply card

Now you can get prompt service on precision, high capacity, Acme Flexible couplings, available in fractional to hundreds of horsepower ratings, direct from your Acme chain distributor.

Acme flexible couplings are used to connect two revolving shafts together, and to compensate for angular and parallel misalignment. Simple to install and disconnect by merely removing one pin.

Maximum capacity is obtained by distributing the load over all the coupling teeth.

An important plus is Acme's use of convex rollers which allow greater angular and radial misalignment. This is accomplished with a minimum amount of backlash. See your Acme distributor.



Each Acme coupling is complete with standard keyways and set screws. Grease retaining felt and snap-on cover can be furnished if required.

**FREE FLEXIBLE COUPLING CATALOG**

Write Dept. 9G for new Acme Flexible Coupling Catalog. Just off the press.

Call ACME for Service

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

For more facts circle No. 52 on reply card


## MANUFACTURERS' LITERATURE

**V-Belt Drive Manual**

Maurey Manufacturing Corp. — This 66-page illustrated manual contains facts and figures wanted by the production man, the engineer and the designer. It is divided into three general sections: V-drive selection, drive design section and a general information section.

**Crawler Tractors**

Caterpillar Tractor Co.—A 12-page booklet, entitled Big Tracks, form DE627, illustrates how the company's largest crawler tractors are engineered and manufactured and it explains the economics of the use of matched tools.

**Roller Chain Catalog**

Daido Corporation — A 16-page catalog No. 106 which describes and illustrates the different types of roller chain manufactured by the company. It includes specification charts and a sub-standard chain data chart. The catalog lists standard sizes of chains from ¼ to 2½-in pitch in single, double, triple and six widths. The roller chains are a combination of pin link and roller link and it is said that every part can be replaced.

**Farm Implements Brochures**

Allis-Chalmers Mfg. Co.—Brochure TL-1711 describes the new No. 310 one-way disk, designed primarily for the WD-45 tractor, but also available with hitches which adapt it for use with other tractors that are equipped with standard ASAE drawbar and remote ram.

Brochure TL-1691 is a fold-out piece featuring the new 200 Series row-crop cultivator for the company's D-14 tractor.

TL-1695 describes the No. 4 subsoiler designed for D-14, WD-45 and WD tractors.

TL-1700 gives data on the No. 63 3-bottom plow, also designed for the D-14, WD-45 and WD tractors.

**Forage Profit Plan**

Gehl Bros. Mfg. Co.—This 4-page folder contains a simplified system, based on impartial findings of agricultural colleges and research stations, to find forage harvesting costs. It contains three tables from which the farmer can pick his present method of hay or silage harvesting and can compare it quickly with other methods.

**Welding Balance Positioner**

Aronson Machine Co.—A 16-page bulletin No. UB57 featuring the company's patented universal balance positioner for welding. The bulletin describes five models with capacities of 25 to 2000 lbs. It includes schematic drawings, complete specifications and optional accessories.

**Hose and Fittings Catalog**

Aeroquip Corp.—Catalog Bulletin No. 182 contains information on the company's line of industrial hose and fittings and is designed primarily for use in the replacement field. It includes instructions for ordering, installation planning and assembly of the company's hose and fittings.

**Farm Gate Catalog**

Clay Equipment Corp.—The 8-page booklet illustrates the company's line of steel gates, fence fabric, gate hardware and fittings. It also describes a tilting device which enables the owner to raise or lower the outer end of the gate, to permit pigs and chickens to pass while large animals are held back.

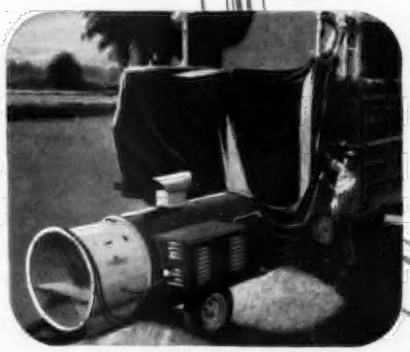
**Perforated Metal Catalog**

Standard Stamping & Perforating Co.— A catalog which shows hole sizes and patterns of perforated metal used in screens, seats, guards, grilles, steps, small parts, etc., for the manufacture of farm equipment.

**1.** **Early morning**—Mower-Crusher starts hay curing fast and evenly

**2.** **Early afternoon**—Rake makes fluffy, quick-drying windrows

**3.** **Late afternoon**—Baler loads directly onto drying wagons



**4.** **Before sundown**—Crop dryer dries hay for morning storage

# Hay in a Day!

*New Holland system is a tribute to agricultural engineering*

**Around-the-clock haymaking**—from standing crop to storage in 24 hours under favorable operating conditions—is the agricultural engineers' answer to the farmer's oldest problem: how to beat the weather. This bold new concept symbolizes the great strides made during the first fifty years of the A.S.A.E.

*Hay-in-a-Day* is a crowning achievement in the agricultural engineers' constant search for faster, more efficient farm machinery that increases productivity while saving man-hours. It is made possible by newly perfected machines that work fast and speed curing—especially the combination mower-crusher, the labor-saving crop-drying wagons and the portable crop dryer designed for the average farm.

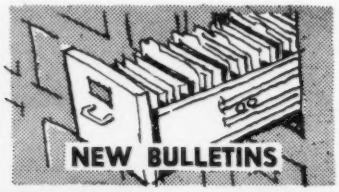
Many other great advances in farm management and economy have been contributed by the agricultural engineers. Many more are sure to come! As they have in the past, the men who serve agriculture at the drawing board will continue to help our farmers lighten their work load, improve quality and increase profits.

We proudly salute the American Society of Agricultural Engineers on its fiftieth birthday. New Holland Machine Company Division of Sperry Rand Corporation, New Holland, Pa.

**NEW HOLLAND** "First in Grassland Farming"



For more facts circle No. 63 on reply card




Lack of space will not permit a review of the following bulletins received recently. However, we would like to bring them to the attention of our readers.

*Effects of Thawing and Refreezing on the Quality of Certain Frozen Foods,* Home Economics Research Publication No. 139, Bulletin 614, November, 1956; *New Concepts in Frozen Food Storage Cabinets,* by John E. Nicholas, Progress Report 163, December, 1956; *A Continuous Flow Automatic Feed Grinder and Mixer,* by R. P. Prince and E. F. Olver, Progress Report 164, January, 1957, are from the Agricultural Experiment Station, Pennsylvania State University, University Park, Pa.

*Factors Affecting the Cost of Storing Grain in Georgia,* by W. S. Rowan, P. C. Bunce, A. R. Brown and J. W. Simons, Bulletin N. S. 27, June, 1956, Georgia Agricultural Experiment Stations, University of Georgia College of Agriculture.

*Bulletin No. 269,* the fourth in the series, on investigations of different methods of rationalizing the harvest of ley crops carried out by the Swedish Institute of Agricultural Engineering, gives viewpoints on the *selection of machinery and the organization of labor for hay drying,* together with instructions regarding the procedure to be used. *Bulletin No. 266,* also from the Swedish Institute, deals with *the effects of the factors affecting the working depth of the mounted plow and the slippage of the tractor.*

Bulletin No. 62.7 on the *Influence of Tillage on Conduction of Heat, Diffusion of Air and Infiltration of Water in Soil,* by R. H. A. Van Duin, is from the Laboratory of Physics and Meteorology of the Agricultural University, Wageningen, The Netherlands. Bulletin No. 26, October, 1956, *Nails and Spikes in Creosote-Pressure-Treated Southern Pine Poles and Timbers,* and Bulletin No. 27, December, 1956, *Plain-Shank vs. Fluted vs. Threaded Nails,* by E. George Stern, were received from the Wood Research Laboratory, Virginia Polytechnic Institute, Blacksburg.

*Reclamation and Melioration,* No. 1, May, 1956, contains abstracts of reports on land reclamation, irrigation and drainage in Japan, and is published by the Agricultural Engineering Society of Japan, Tokyo University.

The bulletin *Transport Development and Locomotive Technology in the Soviet Union,* by James H. Blackman, No. 3, February, 1957, Bureau of Business and Economic Research of the University of South Carolina, is one in a series of essays in economics designed to present various viewpoints, based upon scholarly research, on a variety of economic subjects.

*A Kinematic Study of the Side-Delivery Rake,* by J. H. McClelland, reprinted from the Australian Journal of Applied Science, Vol. 7, No. 2, 1956, for the Commonwealth Scientific and Industrial Research Organization, Australia.

FAO Agricultural Development Paper No. 60, *Water Lifting Devices for Irrigation,* has been published in English, French and Spanish, and copies can be purchased in the United States from Columbia University Press, N. Y.

*Agricultural Meteorology,* by J. L. Dionne, G. W. Robertson, and R. M. Holmes, a brief literature review and bibliography, Experimental Farms Service, Canada Department of Agriculture, 1956.

*Irrigation of Cash Crops,* by F. R. Hore and J. W. Underwood, Western Ontario Agricultural School in cooperation with the Ontario Agricultural College, Ontario Department of Agriculture.

*The St. Anthony Falls Multi-Purpose Test Channel,* by Lorenz G. Straub and C. E. Bowers, Technical Paper No. 17, Series B, July, 1956, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis.

*Economic Allocation of Resources to Supplemental Irrigation,* by John C. Redman and Stephen Q. Allen, Bulletin 649, August, 1956, Kentucky Agricultural Experiment Station, University of Kentucky, Lexington.

*How to Build Homes That Will Outlive the Mortgage,* (second edition), shows how to prevent costly decay and termite damage in homes. Prepared by American Wood Preservers Institute, 111 W. Washington St., Chicago 2, Ill. No. 1, Vol. VIII, 1957.

*Agricultural and Horticultural Engineering Abstracts* are prepared from world literature dealing with agricultural and horticultural engineering and allied subjects. Subscriptions can be arranged by application to the Scientific Intelligence Unit of the NIAE, Wrest Park, Silsoe, Bedfordshire, England.

*Cement and Concrete Reference Book,* 1956-1957, Portland Cement Association, 33 W. Grand Ave., Chicago 10, Ill., is a compilation of facts about the history, manufacture and uses of portland cement and concrete.

ROCKFORD

WHICH KIND OF CLUTCH ?

Small Spring Loaded
For Farm Machines
For Cars and Trucks
Automotive Spring Loaded
Heavy Duty Spring Loaded
For Tractors and Off Highway Machines
For Machine Tools and Production Equipment
Oil or Dry Multiple Disc
Heavy Duty Over Center
For Road Machines and Tractors
For Light Machines and Mowers
Light Over Center
Power Take-Offs
For Oil Field Pumps & Rigs Engine Driven Equipment
For Cranes, Shovels, Etc.
Speed Reducers

There is no one stock answer to every power transmission control problem. That is why ROCKFORD clutch engineers can be of practical help in designing applications that will increase *your* product's efficiency and reduce servicing down-time.

An engineered-to-the-job ROCKFORD CLUTCH application involves recommendations covering the proper type — spring-loaded, over-center, multiple-disc, gear-tooth or splined-to-shaft drive —as well as torque rating, shock-load absorption, slippage control, vibration dampening and provision for frequent drive shaft reversals.

Regardless of your needs, ROCKFORD CLUTCH engineers can specify a size and type clutch that will operate most efficiently in your product—conserving space, power and final cost. Send a print or a description of your clutch need for their recommendations—

**ROCKFORD Clutch Division BORG-WARNER**

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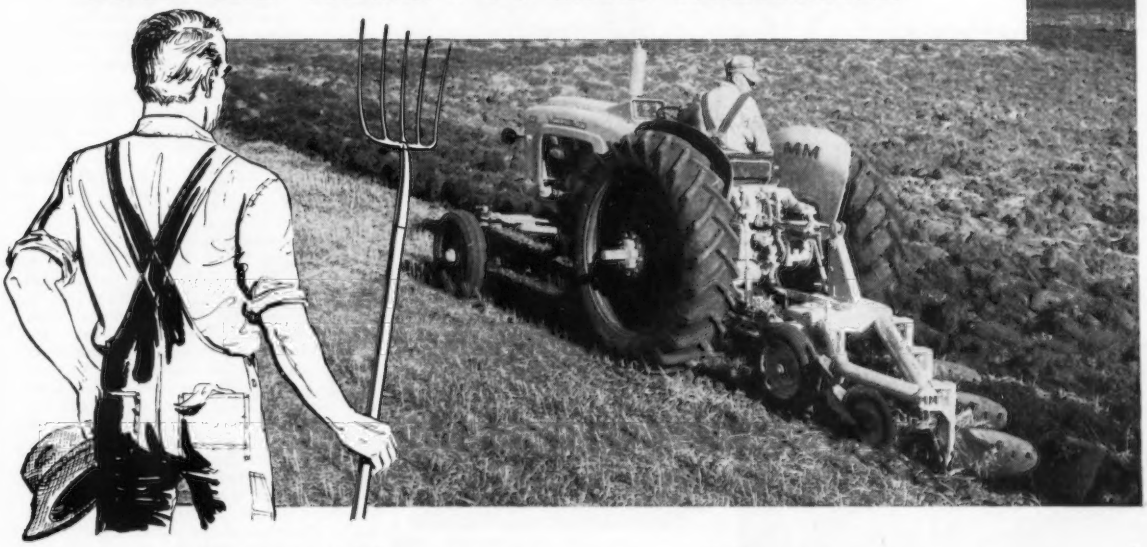
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES

# a strong back? No . . . today's farmer uses his head . . . and machines



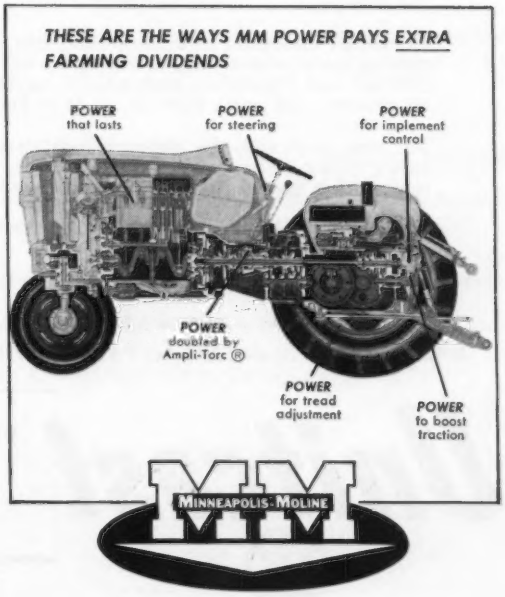
## now from MINNEAPOLIS-MOLINE

# *machines put more power to work in more places!*

A strong back and long hours were the pioneer's stock in trade. Farm jobs *had* to be done by hand. The bigger the farmer, the more work he could do.

Power has changed all that. Modern tractors like the Minneapolis-Moline POWERline series put engine power to work in ways undreamed of in the past. Power for steering • power for implement control • power for tread adjustment • power to boost traction • power doubled by Ampli-Torc® • power that *lasts*. Advances like these don't just save a man's back . . . they mean profits too, the kind of profits a man can put in the bank.

Minneapolis-Moline has introduced many firsts in power farming. In the new POWERline tractors, the 335, 445, and 550, MM offers today's farmer a mobile source of power that works in *new* ways . . . *more* ways to make farming pay better.




*More Power to the ASAE in Its Golden Anniversary Year*

**MINNEAPOLIS-MOLINE**

**MINNEAPOLIS 1, MINNESOTA**

**The company that builds the Uni-Farmor**



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A

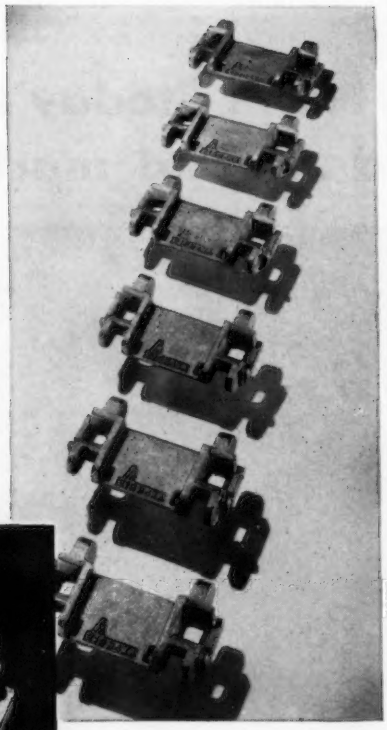
QUARTER MILLION

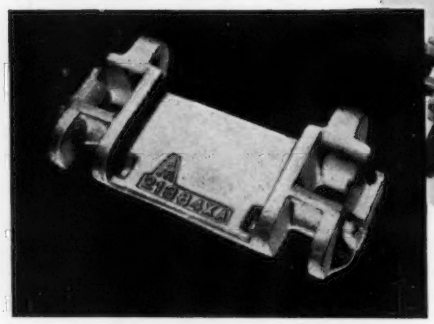
"STEPS"

IN THE

RIGHT

DIRECTION . .





**Today's Modern Miner does BETTER with UNITCASTINGS!**

Real proof of the continuous high quality of Unitcastings is the fact that more than 99 percent of the total production of 250,000 treads has been accepted!

Continual operation in underground grit and dust subjects mining machinery treads to extreme abuse. Replacement is difficult and expensive, particularly on this section of the equipment, and parts must be made to last!

For over a decade, the abrasion-resistance quality of Unitcast's T-Loy 34 has answered this tread problem—as well as many other special parts for the same equipment.

Take a step in the right direction, too—*you'll do better with Unitcastings!* They're Engineered!

UNITCAST CORPORATION • Toledo 9, Ohio

*In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec*

**Unitcast**

**SPECIFICATION STEEL CASTINGS**

**For more facts circle No. 73 on reply card**

## . . . News

*(Continued from page 462)*

ing research will be greater than ever. I would urge our young people to investigate agricultural engineering as a career. It is exciting and rewarding work. It may be in research, developing new machinery that may revolutionize an industry, or devising processing techniques that will lead to new uses of farm products. It may be in operations out on the land, working with farmers on electrification, telephone, or soil and water conservation programs. Jobs like these, and many others, await alert, competent engineers who seek stimulating and worthwhile careers.

Again, I wish to express my appreciation of the honor you have conferred upon me. I shall cherish this membership in your Society and I pray God's blessing upon you and your work.

Ezra Taft Benson

Washington, D.C., May 28, 1957

•

ASAE members taking part in the presentation included J. L. Butt, secretary of ASAE; Wallace Ashby, head, farm buildings section, AERD, ARS, USDA; E. G. McKibben, director of Agricultural Engineering Research Division, USDA; and T. K. Swearingen, manager of agricultural engineering dept., Masonite Corp., Chicago, Ill. J. L. Butt, after presenting the Secretary with an ASAE membership pin, described the Society's publications and explained some of the Society's activities. As chairman of the Washington, D.C. Section, Wallace Ashby welcomed Secretary Benson as a member of the Section and invited him to attend future meetings. T. K. Swearingen, chairman of the ASAE Public Relations Committee, made the arrangements for the presentation in Secretary Benson's office.

### President Bainer Visits Six Sections

Roy Bainer, president of ASAE, had a busy month in April. His schedule included a visit to the Rocky Mountain Section, April 5 to 6, Washington, D.C. Section, April 19, and ASAE headquarters at St. Joseph, Mich., April 22. He spoke to a college group at East Lansing on April 23; was in Brighton April 24 for the Michigan Section meeting, and addressed the Minnesota Section meeting in Minneapolis, April 25. April 26 he was in Moline, Ill. for the Quad City Section meeting, and attended the Ohio Section meeting at Wooster on April 27.

### Annual ASEE Meeting

The American Society for Engineering Education will be held at Cornell University in Ithaca, N. Y. from June 17 to 21. Problems facing engineering schools today, such as, improving high school science preparation, increasing the supply of engineering teachers for the rapidly-growing enrollments, the problems of research and research manpower in engineering colleges, and more efficient use of colleges' limited facilities and staff, will be discussed.

### ASAE MEETINGS CALENDAR

June 23-26 — GOLDEN ANNIVERSARY ANNUAL MEETING, Michigan State University, East Lansing.

August 27, 28 and 29 — NORTH ATLANTIC SECTION, University of Delaware, Newark

October 23-27 — PACIFIC NORTHWEST SECTION, Compton Union Bldg., State College of Washington, Pullman

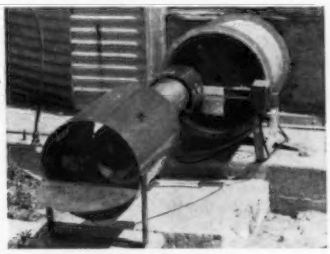
December 15-18—WINTER MEETING, Edgewater Beach Hotel, Chicago, Ill.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

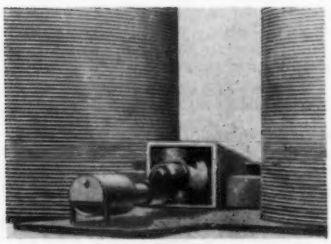
# Field Tested DRYOMATION

## By Farm Fans

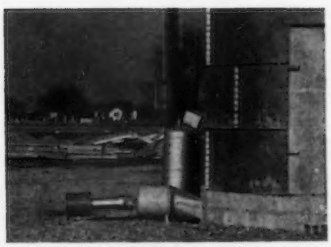
***Drying in storage with supplemental heat added and controlled automatically***



***Easily Attachable***



***Any System***



***Gas or Electric***

Dear Agricultural Engineer:

We invite your attention to our field-proved device, which successfully implements "crop drying in storage with supplemental heat added."

Economically and simply, the bin of grain, drying fan, supplemental heater and controls have been integrated to operate automatically and create a process which we choose to call "dryomation." This is an *original* process.

Uniform drying, no over-drying due to heat, drying of successive layers atop each other, low initial and operating costs, and minimum attention make this process practical for the farmer. It is especially profitable in the storage of shelled corn from the picker-sheller process.

We'd like for you to know more about this Farm Fans development, but space prevents telling the story here. Please mail coupon for your free copy of our paper "A New Approach to Grain Conditioning."

Yours sincerely,

HANK MARKS

P.S. Farm Fans and the Farm Fans Automatic Supplemental Heater are standard equipment offered to the farmer by leading grain bin manufacturers.

**FARM FANS Div., Ewing Foundry Inc., 424 S. Pennsylvania St., Indianapolis, Indiana**

**Yes,** please send me "A New Approach to Grain Conditioning"

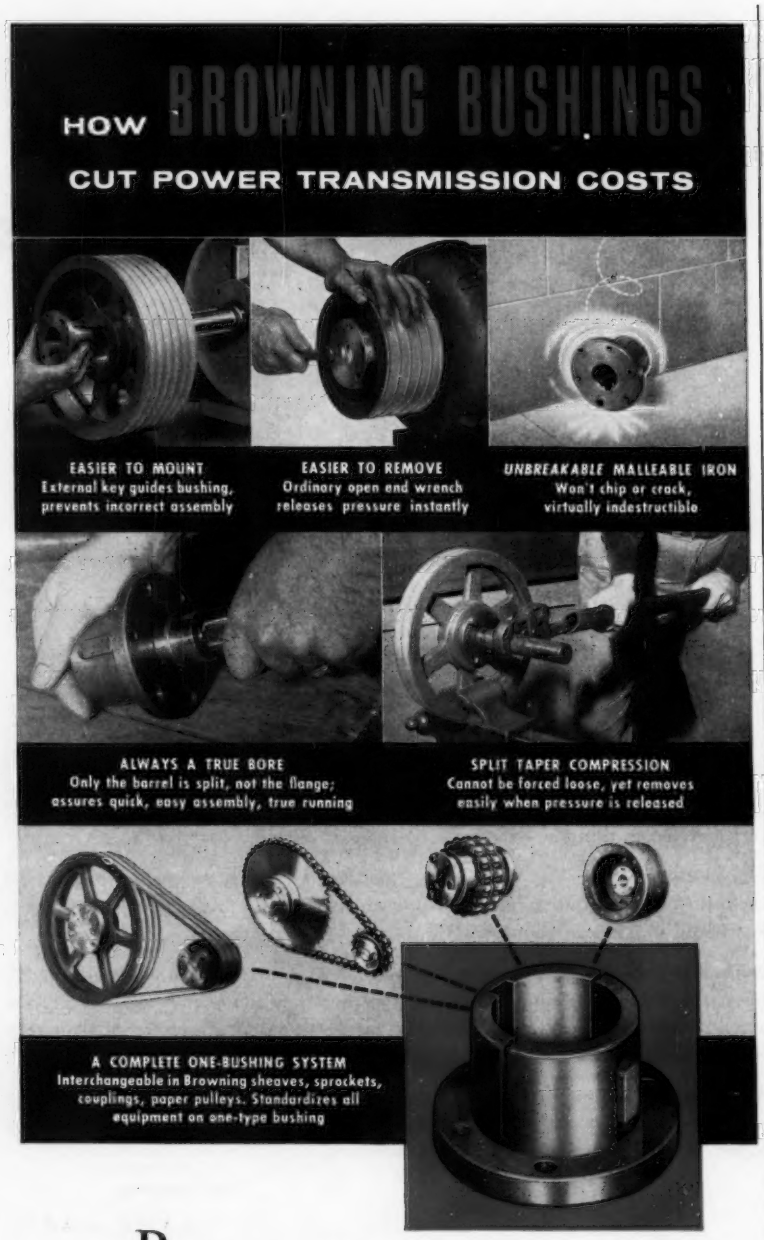
Name.....

Company.....

Address.....



**For more facts circle No. 65 on reply card**


HOW BROWNING BUSHINGS
CUT POWER TRANSMISSION COSTS
EASIER TO MOUNT
External key guides bushing, prevents incorrect assembly
EASIER TO REMOVE
Ordinary open end wrench releases pressure instantly
UNBREAKABLE MALLEABLE IRON
Won't chip or crack, virtually indestructible
ALWAYS A TRUE BORE
Only the barrel is split, not the flange; assures quick, easy assembly, true running
SPLIT TAPER COMPRESSION
Cannot be forced loose, yet removes easily when pressure is released
A COMPLETE ONE-BUSHING SYSTEM
Interchangeable in Browning sheaves, sprockets, couplings, paper pulleys. Standardizes all equipment on one-type bushing

BROWNING'S split taper compression bushing is so simple in construction that you actually can mount and unmount it blindfolded! Grips the shaft with positive clamp-tight action under the most punishing loads, yet always releases instantly for easy removal. With Browning's complete line of sheaves, sprockets, couplings and paper pulleys, this *malleable* bushing provides thousands of size and bore combinations—off the shelf, ready to use without reboring. These features combine to speed installations, reduce downtime, inventories and costs. Compare! Learn how this extensive line can simplify power transmission problems in farm equipment. Write for free catalog GC101. **Browning Manufacturing Company, Maysville, Kentucky.**

Browning POWER TRANSMISSION EQUIPMENT

**For more facts circle No. 72 on reply card**


## . . . Necrology

*(Continued from page 464)*

American Commission to the Union of Socialistic Soviet Republics to study and report on colonization in the Far East. He was a consultant to the War Production Board in 1943 on production and rationing of farm machinery, and later served as consultant to the United Nations Relief and Rehabilitation Administration on allocation of mechanical farm equipment to liberated countries.

Along with his many activities, Dr. Davidson has received several awards among these being the Cyrus Hall McCormick medal in 1933 for distinguished service in agricultural engineering, and in 1942 he was made an "Estranger" member of the Swedish Royal Agricultural Society. In 1956 he was one of five American engineers who were presented with Missouri Honor Awards for distinguished service in engineering by the University of Missouri. He was lauded in the citation for his vision, leadership, and pioneer work in the application of engineering to agriculture, his service to the whole American economy in the development of college instruction in agricultural engineering, and his promotion of high professional standards through his work in professional societies.

He designed several pieces of apparatus and machines, including the Iowa dynamometer and the pulverator and was granted five patents. He contributed articles to many technical journals and was the author of such books as Agricultural Machinery, Farm Machinery and Farm Motors, and Agricultural Engineering.

A past national president of Sigma Tau, honorary engineering fraternity, Dr. Davidson also was a member of Sigma Xi, Phi Kappa Phi, Gamma Sigma Delta, Tau Beta Pi, and Alpha Zeta.

He was a capable planner and organizer. He was sincere and supported a common cause of the farm people. Their burdens were lightened, their production increased and the standard of living raised. He felt that the continuing work of his students here and abroad was the most vital part in his contribution to the profession he helped bring to birth. As Dr. Davidson once stated, "You must have your heart and soul in your work to be a success."

When he was asked how he was able to carry on and make such accomplishments in his field, he told of a prayer he saw in the Des Moines Tribune which read, "O God give me the serenity to accept what cannot be changed, give me the courage to change what can be changed and the wisdom to distinguish the one from the other."

**Ira W. Dickerson,** Life Fellow of ASAE, and agricultural engineer, died May 10 from injuries suffered in a two-car collision at Charles City, Iowa.

A native of Indiana Mr. Dickerson was born in 1874. He graduated from the University of Illinois in 1909 with a B.S. degree in electrical engineering. He almost immediately accepted a teaching position in the department of farm mechanics of that institution. Leaving the university in 1917, he was in charge of the tractor research department of the Hart-Parr Company for several months. In 1918 he became agricultural engineering editor of *The Farmer*, St. Paul, Minn., *Prairie Farmer*, Chicago, Ill., *Wallaces' Farmer*, Des Moines, Iowa, and the *Wisconsin Agriculturist*, Racine, Wis. During the World War II he taught classes in agricultural engineering at Iowa State College.

He served as secretary of ASAE for more than a year and was chairman of its Standards Committee in 1916.

If you are not a member of the American Society of Agricultural Engineers and want (1) to subscribe* to AGRICULTURAL ENGINEERING or (2) to receive information about ASAE membership—or if you *are* a member of ASAE and want to propose the names of one or more prospective members — then simply fill out and mail the card at the right.

(*NOTE: A subscription to AGRICULTURAL ENGINEERING is included in the annual dues of each ASAE member.)

CHECK

☐ I want to receive AGRICULTURAL ENGINEERING regularly. Enter my subscription for one year ($5.00 in USA; $5.50 in Canada; $6.00 elsewhere). Payment is enclosed.

☐ I would like information about membership in the American Society of Agricultural Engineers, including an application form. (I understand that a subscription to AGRICULTURAL ENGINEERING and a copy of AGRICULTURAL ENGINEERS YEARBOOK are included in the annual dues of ASAE members.)

☐ I am an ASAE member and suggest that membership information, including application form, be sent to the name and address below. I can supply names of_____more prospective members. My name is_____.

**Name**_____

**Position or title**_____

**Address (☐ Home or ☐ Business)**_____

**City**_____ **Zone**_____ **State**_____

**Employed by**_____

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Use the card *below* for free data on new products and the card *above* for subscribing to AGRICULTURAL ENGINEERING, or for requesting information about membership in the ASAE.

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**JUNE 1957**

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Your name_____

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| 3 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 |
| 4 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 |
| 5 | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95 |
| 6 | 16 | 26 | 36 | 46 | 56 | 66 | 76 | 86 | 96 |
| 7 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 |
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American Society of Agricultural Engineers
P.O. Box 229
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| 3 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 |
| 4 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 |
| 5 | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95 |
| 6 | 16 | 26 | 36 | 46 | 56 | 66 | 76 | 86 | 96 |
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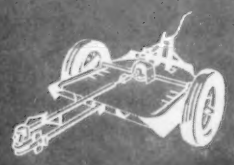

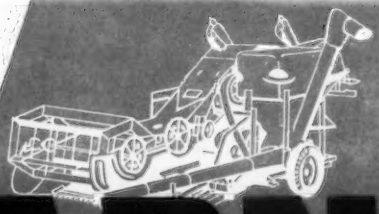

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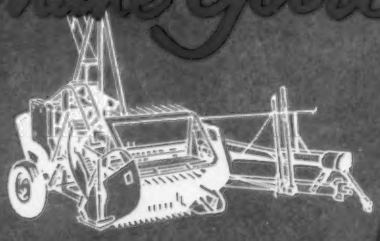
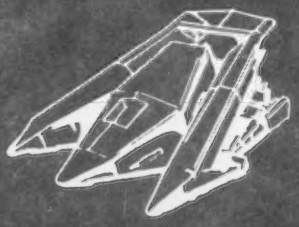
## GEAR BOXES

*Make Good Products* Better*





***FIELD CUTTERS, COMBINES, HAY BALERS, FORAGE HARVESTERS, CORN PICKERS**

Many a farm implement is no better than its gear box. That's why more and more leading manufacturers of rotary cutters, hay balers, combines, forage harvesters and other tools are standardizing on WARNER Gear boxes.

Every Warner Gear box is designed and engineered to transmit power efficiently and dependably, to withstand heavy shock loads. Built rugged, too—with automotive type gearing . . . carburized and hardened gears . . . anti-friction bearings throughout, individually selected for load . . . integrally forged gear and shaft . . . malleable iron housings when necessary.

What's more, Warner mass production techniques and facilities mean lower costs. So if you have a gear box problem, send it to Warner. No obligation, of course.

# WARNER

**AUTOMOTIVE PARTS DIVISION**

ENGINEERING B-W PRODUCTION

**Borg-Warner Corporation**
Auburn • Indiana

*Products of Experience*

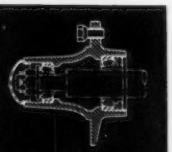
# ELECTRIC
## Wheels · Axles · Spindles

**DIVIDED WHEELS**
Generally used as dolly, tail or caster wheels

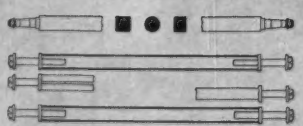
**FOR TRUCK TIRES**
Full drop center rim to utilize used truck tires on larger implements

**PLANTER WHEELS**
Steel rim or for use with planter rubber tires

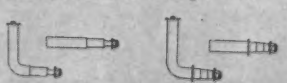
**SIX BOLT SERIES**
Light and heavy —widest range of implement use



Four bolt series for light implements



Hub and bearing combinations available. Stub spindles and full length axles.



*Our Engineers Invite Your Inquiries*

**ELECTRIC WHEEL COMPANY**
DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY
2806 SPRUCE · QUINCY, ILLINOIS

**For more facts circle No. 45 on reply card**

**The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.**

**Amerman, Carroll R.**—Graduate asst., agr. eng. dept., Purdue University, Lafayette, Indiana

**Brumbaugh, Eldon M.**—Chief engr., J. I. Case Co., Racine, Wis. (Mail) 2113 16th Street

**Brundage, John F.** — Chief engr., Allis-Chalmers Mfg. Co., P.O. Box 1112, Oxnard, Calif.

**Butchbaker, Allen F.**—Graduate res. asst., Michigan State University (Mail) 323 Ann St., East Lansing, Mich.

**Callum, Charles L.**—Res. engr., John Deere Ottumwa Works, Ottumwa, Iowa

**Cashman, Vern W.** — Western reg. mgr., Massey - Harris - Ferguson, Inc., Racine, Wis. (Mail) 918 Latham Square Bldg., Oakland 12, Calif.

**Castillo, Neftali**—Head, eng. section, Centro Nacional de Agronomia, Santa Tecla, El Salvador, C. A.

**Chang, Clyde Shi-Kan** — Prof., agr. eng. dept., National Taiwan Univ. (Formosa) (Mail) Agr. eng. dept., National Taiwan Univ., Taiwan (Formosa)

**Chester, Joseph T.**—Div. sales mgr., Chain Belt Co., Dolton Ill. (Mail) 11334 Emerald Ave., Chicago 28, Ill.

**Coleman, Francis**—Agr. engr., FAO Office, Dept. of Agr., Peradeniya, Ceylon (Mail) Katugastota, Ceylon

**DeTar, William R.**—Jr. vocational instr., agr. mechanics, Fresno State College, Fresno, Calif.

**Dickey, L. P.**—Zone mgr., New Departure Div., 3108 23rd Ave., Moline, Ill.

**Fox, Robert D.** — Student, Michigan State Univ. (Mail) 526 Sunset Lane, East Lansing, Mich.

**Gorman, Wm. T.** — Field and shop engr., Thor Res. Center, Farm Div. (Mail) 205 S. State St., Marengo, Ill.

**Graznak, Joseph**—Detail designer, Massey-Harris-Ferguson, Inc., Detroit, Mich. (Mail) 24640 Chernick, Taylor Center, Mich.

**Haen, Eugene**—Res. and dev. mgr., Badger Northland, Inc., 215 W. 2nd St., Kaukauna, Wis.

**Harper, John C.**—Assoc. prof., agr. eng. dept., Univ. of California, Davis

**Henning, Wm. W.**—Mgr. of eng., International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill.

**Hepburn, Dugold** — Engr. advisor, Sudan Gezira Board, Barakat, Republic of the Sudan

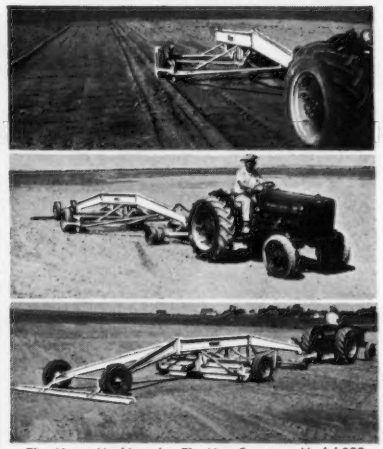
**Hill, Paul W.**—Graduate asst., res., Pennsylvania State Univ. (Mail) R.R. 2, Spring Mills, Pa.

**Johnson, James N.**—Jr. engr., John Deere Spreader Works, East Moline, Ill.

**Kaupke, Charles R.**—Res. asst., University of Calif., Davis, Calif. (Mail) 726 Mulberry Lane

*(Continued on page 490)*


*Moisture Management and LAND SMOOTHING*
WITH AN
# Eversman
LAND LEVELER and DIRT MOVER
*Greatly Increase*
## YIELDS PER ACRE



*The Above Machines Are The New Eversman Model 329*

Eversman engineered fields mean more profits for farmers through greatly increased production per acre. Now the average farmer with his own tractor and at low cost can—

1 Shape fields by grading down high spots, filling in low areas and pot holes that gather water and drown out crops.

2 Build farm-over drainage ditches or grass water ways when needed to get excess rainfall off the land quickly.

3 Increase production on irrigated land. Smooth level surfaces free of pockets, dead furrows and back furrows result in great savings in labor and water with every foot of ground producing uniformly.

4 Produce a better seed bed. The Eversman with spring-tooth attachment is a complete TILLAGE TOOL which produces better seed beds at lower cost. For more details send for the two booklets shown below.

There are 7 all purpose (mechanical or hydraulic) Eversman Models for all standard farm tractors ... for Automatic Land Smoothing, Dirt Moving and Seed Bed Preparation.

**EVERSMAN MFG. CO.**
Dept. 103, Curtis and Fifth, Denver 4, Colo.

**For more facts circle No. 46 on reply card**

# more than just a new tractor a whole New Concept of farm power

Research and development are welded together in Allis-Chalmers farm equipment engineering. From fact-finding research to commercial production . . . one team of engineering and production specialists works together. Through the years this unique coordination has produced unusual . . . even revolutionary . . . farm equipment.

Now, from this pattern, comes the completely new 3-plow D-14 . . . fresh from years of research and testing in Allis-Chalmers laboratories and proving grounds . . . to give farmers everything they have said they wanted.

- Low over-all height with high crop clearance.
- Adjustable easy-ride seat with 4-way shock absorption.
- Low, roomy platform . . . step aboard . . . stand safely.
- Exclusive new Power Director with constant-speed live power take-off.
- Eight speeds forward with quick shift to high and low range . . . on-the-go.
- Roll-Shift front axle and Power-Shift drive wheels for quick, easy tread spacing of all wheels.
- Complete hydraulic system . . . fully enclosed.
- Hydraulic TRACTION BOOSTER system with new Range Selector . . . advanced *automatic* weight transfer.
- SNAP-COUPLER hitch . . . quick job changeovers . . . implements swing and float freely.
- New POWER-CRATER engine . . . years ahead in efficiency and performance.
- Complete line of attached implements.

With developments like these that open new horizons in power application, the D-14 typifies the results of Allis-Chalmers Engineering in Action . . . where research, development, and final production are coordinated by one team of product specialists.

ALLIS-CHALMERS, FARM EQUIPMENT DIVISION, MILWAUKEE 1, WISCONSIN

TRACTION BOOSTER, SNAP-COUPLER and POWER-CRATER are Allis-Chalmers trademarks.

**ALLIS-CHALMERS** A-C ALLIS-CHALMERS



For more facts circle No. 67 on reply card

## . . . Applicants

*(Continued from page 488)*

**Kulshrestha, Surendra P.**—Ext. officer (agr. eng.), Extension Training Centre, Bakshi-Ka-Talab, Lucknow, U.P. (India)

**Kyle, John T.**—Principal engr. and head of the equipment and operations div., Sask. Gov't., Dept. of Agr., Admn. Bldg., Regina, Sask., Canada

**Lee, Leslie D.**—Trainee, Ralston Purina Co., Delmar, Del. (Mail) 146 W. Shaw, Michigan State Univ., East Lansing

**McMullen, Robert W.** — Irrigation sales engr., Southern Pipe & Supply Co., Winter Haven, Fla. (Mail) Ave. C and 8th St., S.E.

**Newman, M. Frederic**—Agr. mechanics student, Michigan State Univ. (Mail) R.R. 2, Hesperia, Mich.

**Ridge, George W.** — Test engr., International Harvester Company, Harvester Farm, South County Line Rd., Hinsdale, Illinois

**Rose, Gene R.** — Student, Michigan State Univ., East Lansing, Mich. (Mail) R.R. 2, Box 336, Buchanan

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**Shy, Frank M.**—Asst. dir., agr. extension, Republic Steel Corp., Empire Bldg., Birmingham, Ala.

**Siemens, John C.** — Graduate asst., res., Univ. of Illinois, Urbana, Ill. (Mail) 306 E. Daniel, Champaign, Ill.

**Smiley, Donald C.**—Sr. engr., John Deere Waterloo Tractor Works, Waterloo, Iowa

**Snyder, Donald** — Student training course, Allis-Chalmers, Milwaukee, Wis. (Mail) R.R. 1, Box 937, Carnegie, Pa.

**Swanson, Allen L.**—Sales engr., New Departure Div., Gen. Motors Corp., 3108 23rd Ave., Moline, Ill.

**Tokunaga, Roger** — Asst. proj. engr., SCS, USDA (Mail) 239 College Ave., Santa Rosa, Calif.

**Vicary, Robert G.**—Des. engr., International Harvester Co. of Canada, Hamilton, Ont., Canada (Mail) 56 Eastbourne Ave.

**Williams, Robert B.** — Instr. of agr. eng., agr. eng. dept., University of Maine, Orono, Maine

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**Bowman, Charles C.**—Asst. prof., agr. eng. dept., Montana State College, Bozeman, Mont. (Mail) 909 West Dickerson (Associate Member to Member)

**Butler, James L.**—Graduate asst., agr. eng. dept., Michigan State Univ., East Lansing, Mich. (Associate Member to Member)

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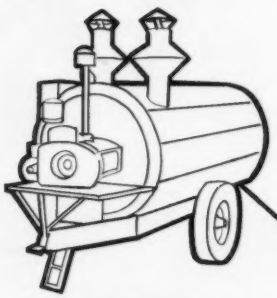

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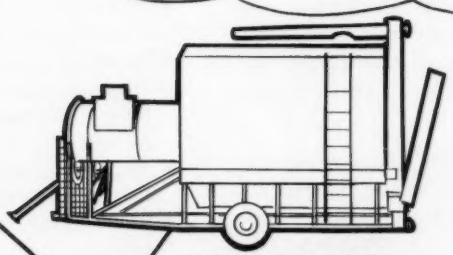

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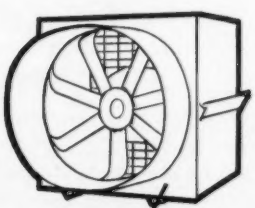

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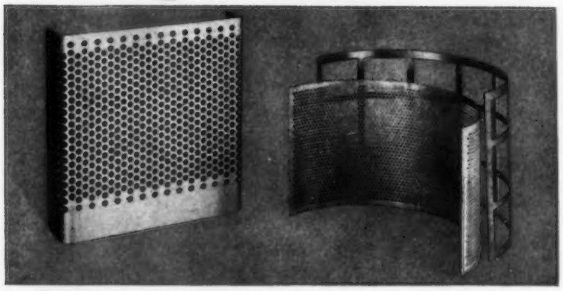

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(a) Project title, (b) cooperating departments and agencies, (c) project leaders, (d) location, (e) brief description, (f) objectives, (g) brief discussion of results, (h) publications and (i) remarks.

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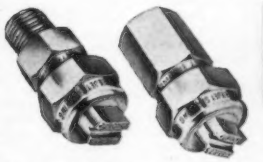

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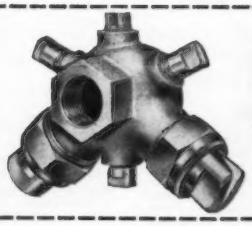

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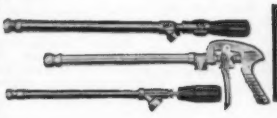

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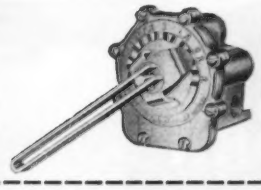

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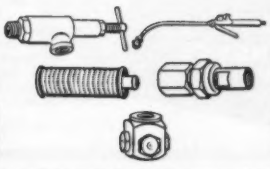

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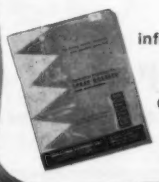

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## PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listings.

POSITIONS OPEN—JANUARY—O-8-701. FEBRUARY — O-14-702, 14-703, 23-704, 23-705, 23-706, 12-707, 28-708, 38-709. MARCH — O-21-710, 52-711, 60-712, 45-713, 45-714, 81-715, 84-716, 70-717. APRIL — O-90-718. MAY — O-141-719, 141-720, 154-721, 154-722, 155-723, 164-724, 165-725, 99-727.

POSITIONS WANTED — JANUARY — W-413-43, 419-45, 422-46, 420-48. FEBRUARY—W-364-47, 13-1, 33-2, 10-3. MARCH—W-61-4. APRIL—W-68-5, 74-6. MAY—W-51-7, 96-8, 128-9, 159-10.

### NEW POSITIONS OPEN

AGRICULTURAL ENGINEER for extension work with special emphasis on buildings and soil and water management in an eastern state. Will also have charge of engineering phases of 4-H program and write extension bulletins. Age under 40. BS or MSAE or equivalent. Farm background. Experience in writing extension literature especially desirable. Usual personal qualifications for public service. Excellent opportunity for advancement. One month vacation. Salary open. O-179-728

AGRICULTURAL ENGINEER, assistant or associate rank, for research on crop harvesting and handling methods and equipment in a northeastern state university. Adjustments possible for individual with definite interests in other research problems. Age under 35. MSAE or equivalent. Experience in crop harvesting, handling, or processing research desirable. Interest in equipment development helpful. Must be able to meet and work well with others. Excellent opportunity for advancement in expanding program. Social Security, group insurance, hospitalization and retirement program. Excellent working conditions. Salary open. O-189-729

AGRICULTURAL ENGINEER for teaching and research in household equipment in home economics department of a large state university in the Midwest. Age 27-35. MS degree in agricultural engineering or related field. Some experience in college teaching preferred. Ability to work with others as well as independently. Initiative and enthusiasm to develop a new program of teaching and research. New building and facilities. Excellent opportunity for advancement. Salary $5600 for academic year. Opportunity for summer employment. O-170-730

AGRICULTURAL ENGINEER for teaching farm mechanics half-time and university service work half-time in a state university in the Midwest. Age under 50. BSAE. Prefer man with MSAE or some experience in teaching, research or extension. Ability to work with students, farmers, industry representatives and other staff members. Excellent opportunity for advancement. Salary open. O-188-731

### NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design, development, research or sales in irrigation and water supply, with industry preferably in South or West. Married. Age 25. No disability. Available in September. BSA, major in agricultural engineering, expected in August, Texas Technological College. Navy experience nearly 4 years as electronics repairman. Engineer trainee 3 months with SCS. Salary $4800. W-186-11

AGRICULTURAL ENGINEER for design, development, research, service, writing or management in power and machinery with experiment station, FAO or manufacturer in USA, Canada or Australia. Married. Age 33. Available February 1958. BSME, 1948, Edinburgh University. MSAE, 1952, Durham University. Executive trainee with large manufacturer for 2 years. Left to accept scholarship. Agricultural engineer in Colonial Service 4½ years in Nigeria, as officer in charge of irrigation project, including experience in testing machinery and methods for production of rice, peanuts and tropical crops. Also research and development on crop mechanization. War experience in Royal Signal Corps. Postwar in Education Corps. Salary open. W-171-12

AGRICULTURAL ENGINEER for sales, service, or writing in power and machinery or soil and water field with manufacturer or distributor in Midwest. Willing to travel. Married. Age 46. BS, 1935, Michigan State College; MA, 1942, University of Toledo. Private pilot's license and radio engineer's license. Vocational agriculture teacher 10 years, US Soil Conservation Service 12 years. Salary, over $5,000. W-180-13

AGRICULTURAL ENGINEER for extension, teaching, research, writing, or management in power and machinery or product processing field, with industry or public service anywhere in USA or other non-communist countries. Married. Age 52. Hard of hearing in one ear. Available now. Hungarian refugee. Last employment, professor of farm mechanization, University for Agricultural Sciences, Budapest, Hungary. Diploma, "Ingenieur-Agronom," 1927, Eidgenossische, Technische Hochschule, Zurich, Switzerland. Managed 600-hectare farm from 1928-41. Employed by Ministry for Agriculture, Budapest, Hungary, 1945-1949; head of department for farm mechanization, 1947-49. Professor and head of department of farm mechanization, University for Agricultural Sciences, 1950-56. Salary open. W-190-14


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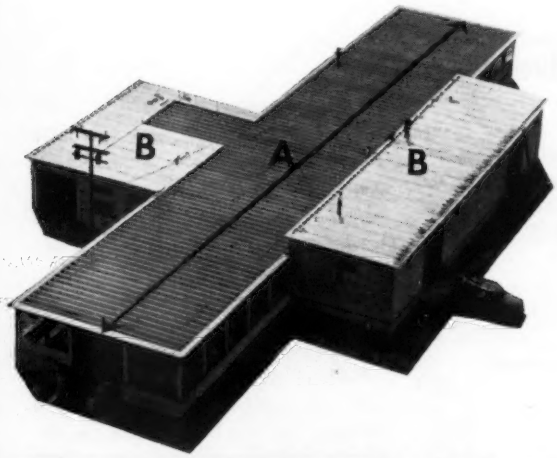


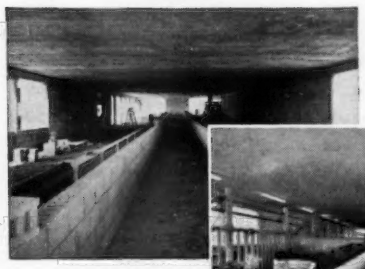

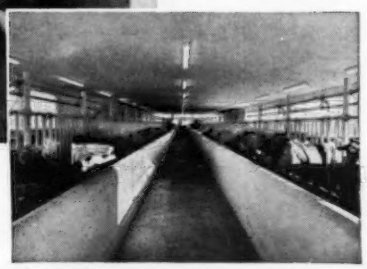

Above: Aerial view of unique roof construction in this dairy barn.
Left: Interior of barn while in construction.
Below: Finished interior.

1907 - 1957

## 50 YEARS OF PROGRESS

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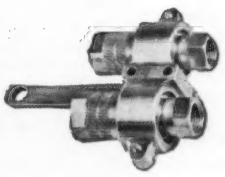

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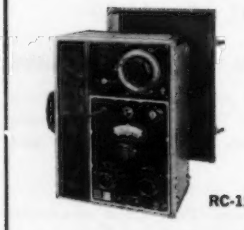
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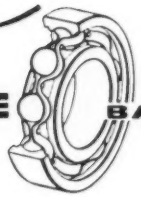
about

## NEW DEPARTURE BALL BEARINGS



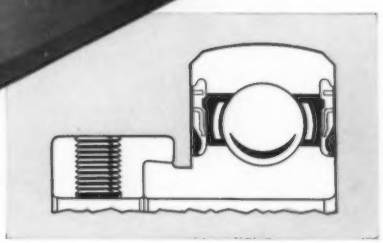
## NOW A NEW DEPARTURE IN PILLOW BLOCKS

- Clean, rigid, compact design.
- Free of any lubricating fixtures.
- New Departure ball bearings sealed and lubricated-for-life.
- Pillow Blocks easily mounted without special tools.
- Only high capacity precision ball bearings used.
- Accommodates any misalignment.
- 31 shaft sizes, ½" through 2 7/16".
- Interchangeable with most makes.

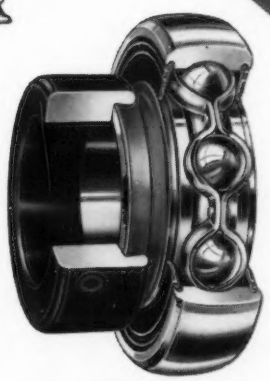
Send for Catalog PBC for complete details.

**GREASE SEALED IN**
**DIRT SEALED OUT**
**with**
**FAMOUS SENTRI-SEAL**



The bearings are easily applied to the shafting and are positively locked in position with an eccentric cam locking collar and set screw.



New Departure Pillow Blocks employ the performance-proved New Departure Type AE Adapter ball bearings with spherical O.D. for alignability and steel-reinforced Sentri-Seals for long life protection against dirt or grease leakage.

**BALL BEARINGS MAKE GOOD PRODUCTS BETTER**

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

**For more facts circle No. 10 on reply card**

**NOW FARMERS ARE PEOPLE, TOO**

Years back, the farmer behind the plow worked almost as hard as the horse ahead of it. Today the horse is gone and so is most of the back-breaking work. Now farmers are *people*—like everyone else.

It's because of America's ceaseless search for a better way to do things. A conviction that "good enough" isn't. We call it Better-ness. It created the first reaper. Then the binder and tractors and combines. And all the machines that now help 2,000,000 fewer farmers feed 30,000,000 more people—just since 1940.

Making this farm mechanization possible are Timken® tapered roller bearings. They are at the hub of Better-ness—keeping wheels and shafts turning smoothly.

Timken bearings *roll* the load instead of sliding it—practically eliminate friction. Their tapered design lets them take the punishing loads of farm work, both up-and-down and sideways. They reduce breakdowns—need less maintenance. Timken bearings can go an entire season with little or no attention.

Always specify Timken bearings in the machines you design and build—because Better-ness rolls on Timken roller bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

*Every make of American tractor uses Timken bearings—more and more implements are using them,*

# This is BETTER-ness

*America is for it and* **TIMKEN**® *bearings help you get it*

**For more facts circle No. 11 on reply card**

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